DISEASES OF THE EYES

C. DEVEREUX MARSHALL

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FULLY ILLUSTRATED

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PREFACE

This book is chiefly designed for the use of students and those practitioners who while doing a certain amount of eye work cannot be considered as experts. With this object in view an endeavour has been made to make the book as practical as possible, and not to insert an amount of detail which is only necessary in the larger text-books, which are chiefly read by those who are engaged in ophthalmic work only.

As far as possible the individual views of the author are emphasized, as it was felt that to give several alternatives for arriving at the same result would be only confusing to the student. If statements are found which are considered too dogmatic, it is due to this, and not to prejudice. Larger books are always available for those who wish to go more thoroughly into the question of debated points.

Opportunity has been taken to explain at length the Edridge-Green theory of light and colour vision, as it was felt that the subject is insufficiently grasped by many people even now, but as there can be no question as to its truth and of the satisfactory way in which it explains every fact of colour-blindness it is hoped that the chapter will be found to be clear and explicit. Dr. Edridge-Green has himself kindly read it, and it embraces several suggestions he was good enough to make.

The drawings here are from various sources. Those representing the examination of the eye were all drawn from photographs taken by the author for the purpose of illustrating a very useful book on *The Examination of the Eye*, by his friend and colleague Mr. William Lang. Mr. George

Berry of Edinburgh kindly gave permission to use the illustrations in his *Manual of Practical Ophthalmology*. Mr. Claud Worth and Mr. Bishop Harman were both kind enough to write descriptions of their operations for squint, and to lend the blocks for their illustration, while Mr. T. Harrison Butler wrote out a description of his method of removing the lacrimal sac. Messrs. Weiss & Son, Messrs. Curry & Paxton, and Messrs. E. B. Meyrowitz and Mr. A. Hawes have lent several blocks illustrating instruments; to all of these the author wishes to express his thanks. In the final chapter a fairly comprehensive list is given of the visual requirements of the public services, and it is hoped that any one who examines prospective candidates will really adhere to the regulations and advise accordingly. Much disappointment will be saved to candidates if surgeons will realize that these standards cannot be departed from. All except the regulations of the Board of Trade are plainly written and easy to follow.

C. Devereux Marshall

Harley Street,
November 1912.

CONTENTS

CHAPTER I

CHAPTER II

CHAPTER III

CHAPTER IV

CHAPTER IX

CHAPTER X

CHAPTER XI

CHAPTER XII

CHAPTER XIII

LIST OF ILLUSTRATIONS

DISEASES OF THE EYES

CHAPTER I

EXAMINATION OF THE EYE

A careful and systematic examination is the first essential when undertaking the investigation of eye diseases, otherwise many conditions which are present are likely to be overlooked.

The parts which an ophthalmic surgeon is called upon to investigate may be divided broadly into two—(1) the eye itself, and (2) the ocular appendages. The eye cannot be satisfactorily examined without a good light, and although for many external conditions nothing exceeds daylight, yet there are many parts of the eye for which artificial light is absolutely essential, and frequently the examination has to be conducted in an otherwise darkened room so as to get rid of the effect of extraneous light, which often gives rise to troublesome corneal reflexes, and may altogether prevent the seeing of certain small things giving valuable information as to the state of the eye.

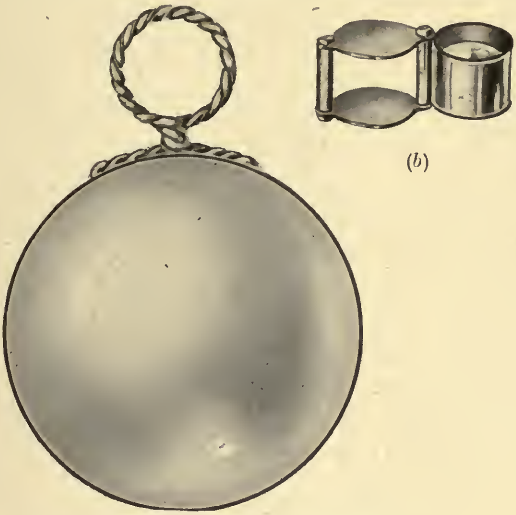
A general inspection of the two eyes and face must first be made in a good light, daylight by choice, and in this way affection of the eyelids or conjunctiva may best be seen. Notice should be taken of the position of the two globes, whether, for instance, one is more prominent than the other. By making the patient look in various directions, the movements of the eyelids and of the eyeballs may be examined. The margins of the lids should be carefully looked at with a view of ascertaining if the eye-

lashes are in their proper position, and whether the puncta occupy their normal situations just resting against the ocular conjunctiva. Redness and injection of the eyeball is far better judged of by daylight than by the more yellow beams of gas or electric light. The lower lid should be drawn down and the patient told to look up, so as to expose the lower palpebral conjunctiva, while if he look down the upper lid may be everted and the upper palpebral conjunctiva and the cul-de-sac may be fully exposed.

Much information concerning the cornea may be obtained. In health it is perfectly smooth, and the reflection of objects such as the bars of a window, before which the patient may be standing, can be seen clearly and with no break in the image. If, however, the surface is rough, the reflex is not quite regular. A still better view may be obtained by focusing the light on the cornea with a 3″ convex lens, which is by far the most useful instrument in the outfit of any one engaged in investigating ocular conditions. In a similar manner, the aqueous and iris may be inspected, but in health the aqueous is so clear that it is invisible. Any irregular condition of the pupil or abnormality in the pupillary reflex is to be noted. Adhesions between the iris and lens capsule (posterior synechiæ) are often made visible, though they are sometimes not seen except when the pupil is dilated or in a dark room. A good view of the puncta of both upper and lower lids must always be obtained, as their appearance frequently suggests disease of the lacrimal sac, while it should never be forgotten that foreign bodies such as loose eyelashes not infrequently become lodged in one of the puncta, and cause great irritation near the inner canthus. The punctum of the upper lid is almost as liable as that of the lower to get some such body as this into it.

Pressure over the region of the lacrimal sac may cause regurgitation of fluid, clear or purulent, into the conjunctiva, thus at once showing that some morbid condition of this structure exists.

It is sometimes necessary to ascertain whether the passage from the lacrimal sac into the nose is open. This can be done by passing a syringe along the canaliculus into the sac and injecting fluid. If the duct be patent the fluid will pass out of the nostril if the patient's head be held forwards, or down the throat if the head be held back. Should, however, it be undesirable to do this, a drop of fluorescin may be instilled into the conjunctival sac.



(*b*)

Fig. 1 (*a*).—Convex lens, (*b*) corneal loupe.

After a few minutes the patient is directed to blow his nose. If the duct be free the fluid in the handkerchief will be found to be stained bright green by the fluorescin. Should this not be the case there is probably some obstruction, and the syringe should be used.

The canaliculus if dilated is quite large enough to allow a probe to be passed into the sac and down the nasal duct without any cutting. It is never necessary to slit a canaliculus, no good can come of it, and the efficient drainage of the conjunctival sac can never afterwards be satisfactorily carried out.

The cornea can be best examined in the dark room in which is a good lamp of any sort. It is not advisable to use too strong a light. A 16 C.-P. electric lamp, by choice a focus lamp in which the filament occupies the central position of the lamp only, is all which is required, but it should be made of ground glass so that the filament is invisible, but the source of the light is all at one point

Fig. 2.—Oblique examination.

and not spread over nearly the whole lamp, as it is in those which are in common use for illuminating purposes. An Argand gas-burner is excellent, but is very hot, and soon vitiates the air in a room if used for a long time. An ordinary paraffin lamp is quite good, but as a rule it is awkward to use, unless it be mounted on a bracket, so that it can be placed in any position. The larger electric lamps of 32 C.-P. and upwards are unsuitable for ophthalmic work, as the light is far too intense and is trying for both the patient and the surgeon. The bull's-eyes

which are used for throat and dental work are not required in eye work. With such a light as this, aided by an ordinary pocket lens (Fig. 1, *a*) for the purpose of focusing the rays on some particular part of the eye, and a corneal loupe (Fig. 1, *b*), all things are rendered visible which can be seen by transmitted light (Fig. 2).

Reflected light is necessary when examining the deeper parts of the eye, and in order to obtain this the light is taken from the lamp above described and reflected by a plane or concave mirror into the eye to be examined.

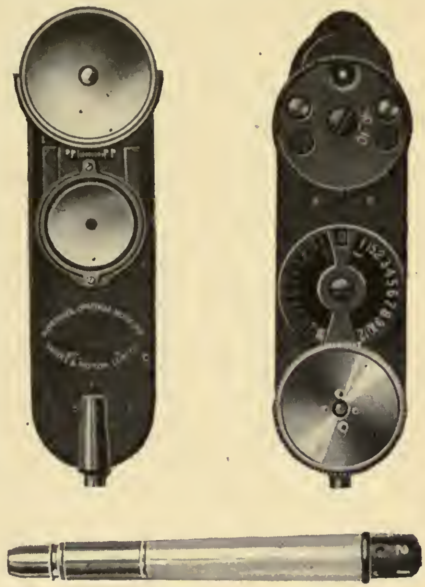


Fig. 3.—Morton's ophthalmoscope.

Most ophthalmoscope mirrors are concave, and the object of this is to obtain a more concentrated light than would be possible from a plane mirror. For the indirect method of examining the fundus this is of great use, otherwise much of the light from the mirror is lost and a poorer illumination of the fundus is obtained. On the other hand, there are many minute things such as fine vitreous and lenticular opacities, vessels and spots in the cornea, etc., which are far better seen with the plane mirror than with the concave, and the reason for this is that with too much illumination these small objects are not dense enough to obstruct the powerful rays, and thus they are difficult or impossible to see. Many of these things may be seen when sitting a few feet from the eye which is being examined, but a better and more detailed view is obtained

by the observer coming quite close to the patient. If then he throws up a strong + lens behind the plane mirror such as a + 12, or if the cornea be under observation a + 20, a very excellent view of the media of the eye is apparent.

When using an ophthalmoscope or mirror the strongest + or the weakest – glass with which he can see the desired object should be employed. If this be not done the surgeon's own accommodation is called into very active play, with the result that before he has done much work he has developed a headache, and the eyes will feel so tired that he is unable to continue with comfort. With a mirror and a + glass varying in strength from + 0·5 to + 20, opacities in any of the media may be seen to great advantage, as well as a detailed view of the fundus.

A very good method for examining the cornea and iris, and sometimes the lens as well, is to use the oblique illumination, which consists of focusing the light from the lamp by means of the ordinary convex lens of about 3″ focus, on to the cornea, and thus magnifying the part looked at with the corneal loupe, which is a strong + lens made in such a manner as to get over as far as possible spherical and chromatic aberration, and thus to produce a flat field. This method shows up well such things as small foreign bodies on the cornea, old or new vessels, dots of keratitis punctata, vessels or growths in the iris, and some lenticular opacities (Fig. 2).

The retina, optic nerve and choroid must be examined with the ophthalmoscope. There are two ways of using this instrument, one called the indirect and the other the direct method.

Indirect Method (Fig. 5).—This is the method used when a good all-round view of the fundus is required. It is so called because the fundus itself is not seen, but an inverted aerial image is formed between the lens held by the surgeon and his own eye and is at the principal focus of the lens.

The patient and surgeon enter the dark room. The

lamp is placed at the side of or above the patient's head, but with his eye in the shade, and he is directed to look straight in front of him. If the patient's right eye is to be examined the surgeon places himself in front and to the right side of the patient, and takes his large con-

FIG. 4.—The normal fundus.

cave mirror in his right hand and holds it with the sight hole before his right eye, and directs the beam of light reflected in the mirror from the lamp into the eye to be examined. He thus sees the bright red reflex in the pupil. Now with the left hand he holds the lens about three inches in front of the patient's eye. This collects the rays of light emerging from the eye, and forms

an inverted aerial image of the fundus between the lens and the surgeon, which is found at a position about ten or twelve inches from the surgeon's eye. Inasmuch as it is important for the surgeon to save his own accommodation as much as possible, a lens of about + 2D should be placed behind the mirror so as to allow of this comparatively near image being seen with as little effort as possible (Fig. 5).

If the left eye is to be examined, by far the better plan is still to direct the patient to look far away into the distance, while the surgeon places himself in front and to the left side. He now holds the mirror with the left

Fig. 5.—Indirect method of examining the eye.

hand before his left eye, and the lens he holds in his right hand before the patient's left eye.

Thus the surgeon always examines the patient's right eye with his right eye, and the left eye with his left eye. It is practically impossible to do anything else with the direct method. For the indirect method it is far more convenient, for the simple reason that if the patient be told to look away into the distance, it induces him to relax his accommodation, and the pupil dilates by virtue of the darkness of the room, and because the accommodation is being relaxed, whereas if the surgeon places himself immediately in front of the patient and directs him to look at his ear or little finger, as is so often recommended, the patient must accommodate to do this, and

this renders his pupil smaller than it would otherwise be, thus impeding the view of the surgeon. If the light be directed from a point slightly to the outer side of the patient it strikes directly on the optic nerve, which is the blind spot, and this does not cause contraction of the pupil, thus a clear view is almost always to be obtained. Another advantage is that it enables the surgeon to use his own eyes equally, and thus materially lessen the strain on the one eye (usually the right) which some observers always use. If the surgeon possesses two equally good eyes there is no reason why he should not use them both, and by the method mentioned he will be able to satisfactorily examine the fundi of many eyes without a mydriatic, which it would be difficult or impossible to do otherwise.

Direct Method.—By this method a much more detailed examination of the fundus is obtained. A smaller portion of it is visible at any one time, but what is seen is more magnified than that seen with the indirect image. Consequently many details and small changes become apparent which would easily otherwise be missed.

In using this method the light must be placed slightly behind and about on a level with the ear of the patient on the same side as the eye which is to be examined. The small tilted mirror of the ophthalmoscope is turned so that its surface is directed towards the light.

If the patient's right eye is to be examined the surgeon uses his right eye, and places the ophthalmoscope close to it; he then gets as close to the patient's eye as possible, and directs the reflected light straight into it. If now the patient looks straight forwards the surgeon will be directly opposite the disc, which will be at once seen. Should the left eye be the one under examination the surgeon must use his own left eye, for if he tried to use his right eye the noses of the patient and surgeon would come into contact before he was near enough to obtain a satis-

factory view of the fundus. It is absolutely essential for the surgeon to use the eye corresponding to the one to be examined when the direct method is put into practice.

There is, however, one thing to be remembered with regard to the direct method, and that is that it is impossible for a clear view of the fundus to be obtained unless both the eye of the surgeon and that of the

Fig. 6.—Direct method of examining the eye.

patient are emmetropic. Therefore if either has a refractive error it must be corrected by a lens thrown up behind the ophthalmoscope, which shall represent the combined error of the two eyes. If, however, either or both eyes be hypermetropic the surgeon can use his own accommodation to correct the error, but this should never be done if it can be avoided, for in the first place it causes a great strain on the surgeon's eye, and in the second

place the refraction of the patient's eye, or the height of a swelling, or the depth of a depression cannot be estimated. It is, therefore, necessary for the surgeon to relax his own accommodation, and he should endeavour to use the highest + glass or the lowest − glass with which he can see the fundus details clearly. This glass will measure the combined error of the surgeon and the patient, and as the former, if any, is presumably known, a simple addition or subtraction will give a measure of the patient's error.

The beginner will find it by no means easy to relax his accommodation at will, and especially when he knows that he is looking at a very near object which he finds it difficult to see; he is almost certain to strain to see it, and thus to throw in a great deal of accommodation. If he does this he vitiates his results, and he fails to find out the refraction of the eye, and is altogether incapable of measuring the height, say, of the swelling of the head of the optic nerve in a case of optic neuritis, in addition he probably develops a head-ache or eye-ache after using the ophthalmoscope for a short time. Whereas if he makes the lenses do the work of his accommodation he will find out far more about the condition of the eye, and he will also be able to spend hours using the ophthalmoscope without feeling the least pain or fatigue.

Examination of the Refraction of the Eye.—There are many ways in which the refraction of the eye can be measured. The simplest but at the same time the least satisfactory method is to put up certain lenses in a trial frame in front of the patient's eye and let him select the one with which he sees best. If the eye had no accommodation it would be quite accurate, and as satisfactory as focusing an object in a telescope. Inasmuch, however, as there would be no telling whether the patient was altering his own refraction by his accommodation, it is impossible to place any reliance on this method unless the eye was aphacic (as happens after the removal of a cataract) or unless he

were so old that all his accommodation had been lost. It scarcely ever happens that a patient is able to select a glass

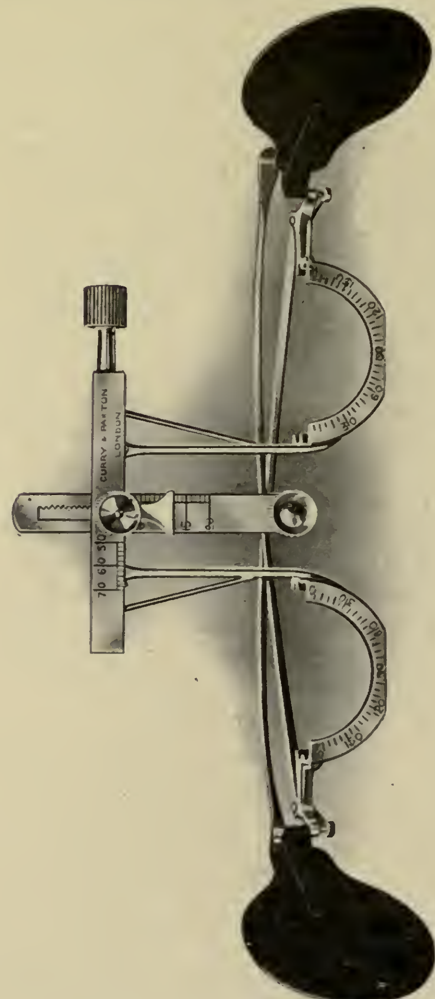


FIG. 7.—Trial frame.

which corrects his refraction properly. Hypermetropes invariably select a glass which is too weak, and myopes

always select one too strong, therefore no reliance can be placed upon a patient's statements unless the surgeon knows by his own observations what the refraction of the eye really is.

In patients who are old enough to be able to give accurate answers the practice of putting up the lenses and recording the vision should always be done, but in young people, and in those who have a fair amount of accommodation, this should only be looked upon as a means of proving the surgeon's observations, while his judgment of what glasses he should order ought to be modified only in the smallest degree by what the patient tells him. He should have worked out the problem with sufficient accuracy to know within narrow limits the glass which will correct the error found. It is, however, a great help to get a reliable patient to say at which axis a cylindrical lens gives the best sight, as this fine adjustment cannot always be made with absolute precision by means of the ophthalmoscope or retinoscopy mirror. This statement applies particularly to those cases which are worked out without the aid of a mydriatic, which has frequently to be done.

Retinoscopy.—This is the most reliable method we have for ascertaining the refraction of an eye. It is called by various names: skiaskopy, the shadow test, etc.

It depends upon the fact that if a beam of light is thrown into the eye from a plane mirror, the dioptric media of the eye in emmetropia form a clear image or spot of light upon the retina much like the spot of light which is made when the sun's rays are collected by a convex lens. Now if this lens be held either too near or too far away from the object on which the beam is directed, a less intense but a larger and more blurred spot of light is seen. In the eye precisely the same thing happens. Suppose we have an eye in perfect focus, and the patient is in the dark room with a light above or to one side of him, but so arranged that the rays do not shine into the eye. The surgeon now places himself facing the

light and about three feet from the patient. With the mirror in one hand he holds it close to his own eye and looking through the sight hole he directs a beam of light into the patient's eye. The whole pupil is at once illuminated with a bright red reflex. If he rotates the mirror on a horizontal, a vertical, or oblique axis, he will see the spot of light travelling in the same direction as he moves the mirror; or what is more correct, he will see the dark shadow following the bright light in every direction in which it is moved.

In hypermetropia the rays of light will not have met when they reach the retina, and consequently a larger area will be illuminated, but at the same time the bright and well-defined quick-moving shadow will be replaced by a less bright illumination and a less clearly defined shadow. If, however, we place convex lenses in the trial frame (Fig. 7) in front of the patient's eye we shall gradually increase the illumination of the fundus until we get it as bright and as sharp as in the emmetropic eye, but the shadow will still move in the same direction as the mirror.

If, however, we have a myopic eye to deal with, or, what amounts to the same thing, if we place a too powerful convex lens in front of a hypermetropic eye, we shall see that the shadow no longer travels in the same direction as the light, but will now move in the opposite direction, and we shall notice that when we tilt the light up the shadow moves down and vice versa; the same of course applies to movements in every direction. Now the reason for this is, that the rays of light have arrived at their principal focus and have crossed before they have reached the retina, and having crossed they naturally move in a reverse direction, just as when we balance a stick in the middle, the part beyond the fulcrum moves down when the other end moves up. On the near side of the fulcrum it would move in the same direction until the fulcrum is reached, when no movement at all would take place, and it is obvious that if a ray of light moves in one direction in one part of its course, and in the reverse

direction at another part of its course, there must be one place where it does not move at all.

Now in order to put this test into practice it is well first of all to have a patient whose eyes are atropised, so that we shall have a dilated pupil and a paralysed accommodation. The examiner seats himself as before described about three feet in front of the patient, who has a pair of trial frames on. He then shines the light from the plane mirror into the eye. If he has a case of hypermetropia to deal with, he will notice that there is a somewhat badly illuminated fundus reflex, and on tilting the mirror the shadow will move in the same direction. Now he inserts convex lenses into the trial frame, when he will notice that the fundus reflex becomes brighter, the shadow more defined, and its movements much quicker. As full correction is approached the shadow will be noticed to scarcely move at all, until at last a lens will be placed before the eye which will cause its reversal, showing that the glass over-corrects the error. The glass next weakest to the one which reverses the shadow is then noted as being correct, and with it little or no motion will be observed. As in every case of astigmatism two axes have to be marked, it is convenient always to make a cross X or + indicating the principal meridians; thus, in the case of hypermetropia we are dealing with, we might find that + 6 reversed the shadow, and + 5·5 barely gave a shadow at all. It should be recorded thus $\overset{+5\cdot5}{+}\,{}_{+5\cdot5}$

The same is done if dealing with a case of myopia of a similar amount, when we should find that a − 6 made the shadow go with the mirror, but a − 5·5 would virtually do away with the shadow altogether, and anything less would give a distinct shadow in the reverse direction to which the mirror was being moved. We should here consider − 5·5 as correct.

It has previously been stated that in emmetropia and hypermetropia the shadow goes with the mirror, therefore if we go beyond that point and abolish the shadow altogether, or still more produce a reversal of it, we must have over-corrected the case. When the shadow is abolished and we are sitting at a distance of not more than arm's-length from the patient, we shall have over-estimated the correction in hypermetropia by about 0·75 or 1·0 D, or under-estimated it to the same extent in myopia. Nevertheless the lens should be written down which practically abolishes the shadow, as the figures on the diagrammatic cross ought always to represent the retinoscopy correction without any addition or subtraction. It is far better to have all the working done on paper than to trouble with mental calculations, which are bound to confuse any one who sees the notes afterwards, and who does not know what the original observer may have allowed for the error. If this patient whose refraction we have recorded as + 5·5 be taken out of the dark room and put in front of the test type, it will probably be found that $\frac{6}{6}$ vision is obtained with + 4·5. When this is ascertained the fact is written down. The patient, however, is under atropine, and this induces another error, for inasmuch as the accommodation is now totally paralysed, and under normal condition, there is always some tone about the muscle which cannot be fully relaxed, we should find that something very much short of $\frac{6}{6}$ would be obtained with a + 4·5, but that good vision would be obtained with + 3·5.

Now on the patient's notes it should be recorded as follows :—

Under atropine +5·5 (vertical) / +5·5 (horizontal)

Vision = + 4·5 $\frac{6}{6}$.

Without atropine vision = + 3·5 $\frac{6}{6}$.

Therefore + 3·5 should be the glass ordered.

If we wished to do so we could eliminate the first error altogether, for it is due to the fact that the surgeon was sitting too close to the patient. If he were to remove himself to a distance of four metres he would then discover that the shadow would be neutralized with + 4·5 instead of + 5·5; but it is obviously very inconvenient and quite impracticable to conduct a retinoscopy at that distance, and inasmuch as when sitting in close the error is known, it makes no more difference to the working than it does to telling the correct time by a clock which is *known to be* so many minutes fast or slow.

It is essential to remember that the error has to be allowed in the reverse direction when we are dealing with a case of myopia. In hypermetropia we over-corrected the refraction, but in myopia we shall under-correct it. A moment's thought will show that this must be the case. Therefore if we find that our retinoscopy gives us $\overset{-6}{\text{—}\!\!+\!\!\text{—}}_{-6}$ when sitting near, the real lens the patient will see with ought to be − 7, and if we again allow 1D for the atropine, his full correction will be − 8. If we make out that an eye is *more* hypermetropic than it really is, it is precisely the same error as making out that an eye is *less* myopic than it really is.

When doing a retinoscopy the clearest and brightest shadow will be found when the light is directed upon the disc, and it is always quite easy to see what the shadow is doing at this place. However, this happens to be the blind spot where no vision is possible, and it is the macula which we must get into focus. Now this is easy enough to do if the eye is under atropine, but it is almost impossible to do it in most people if the pupil is active. When light is directed upon the blind spot the pupil is unaffected, but when it shines on the macula it at once gets small. The refraction at the blind spot and at the macula is in many instances the same, but it is not invariably so, and it may be found to be two or three dioptres different. We

must, therefore, endeavour to make sure that what we have recorded is the retinoscopy of the macula. If the pupil be active it is in nearly all cases possible to do a retinoscopy over the disc, and this is frequently of the greatest value, but we cannot be certain without testing the patient at the types that this is really his macular refraction. Frequently, however, it is possible with a moderately large and active pupil to see what the refraction is even over the macula, particularly if one is used to doing refraction work.

In doing retinoscopy without atropine the essential things are these. (1) The patient must be old enough to do what he is told, and when he is directed to look away in the distance he must really do so, and not fix the light or look hard at the surgeon. By this means he does all he can to relax his accommodation and to render his pupil large. (2) The surgeon must get somewhat to one side of the patient, so that his own head does not come in the direct line of the patient's vision; if it does the observed eye is certain to accommodate for the near object. It is thus obvious that the surgeon must place himself to the right of the patient if he is looking at the right eye, and to the left of the patient if he is looking at the left eye. This necessitates his using each of his eyes alternately. If he takes up these two positions he is exactly opposite the disc of the eye which he is examining.

Examination of the Extrinsic Muscles. — *See* chapter on Diseases of the Ocular Muscles.

Test for Binocular Vision.—It frequently becomes necessary to determine whether a patient has binocular vision or not; that is, the power of fusing into a single image any object which may be viewed with the two eyes together. Among the various tests may be mentioned that of *Cuignet*. It consists of making the patient read ordinary print, and while so engaged a pencil or a narrow paper-knife is interposed half-way between the patient's eye and the paper. If he continue to read

uninterruptedly he must be using the two eyes, but if the interposed object obliterates certain words or letters, only one eye is being used. Any one can practise this for himself by first using the two eyes and then closing one eye or the other. If the right eye is first closed, certain

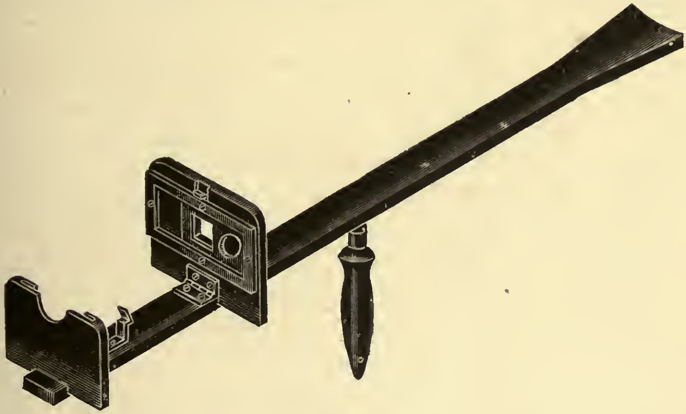


Fig. 8.

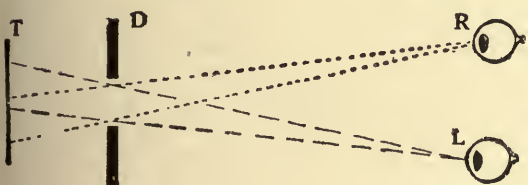


Fig. 9.

A large selection of Screens
in Chippendale. Sheraton,
Louis XV. and XVI. and other
styles, also Lattice Screens,
Japanese Screens, Cheval and
Wing Screens An example
of value, the Four-Fold

Fig. 10.

letters or words are obliterated by the pencil, and if the left eye be then closed and the right opened certain other letters are obliterated.

Snellen's Method is very convenient, and is used not only as a test for binocular vision, but also for the purpose of detecting malingering. The test consists of obtaining a series of transparent letters alternately red and green, while two coloured discs made out of pieces of glass of exactly the same colour are put in the trial frames. The letters which are in a frame are now hung up before

a window while the patient has the trial frame on. He is now able to read the green letters with the eye which has the green glass before it, and the red letters with the eye which has the red glass before it. If now he is able to read both the red and green letters, it is proof positive of his using both eyes, while if he only reads the red letters, or only the green, he must be doing this with the eye which has the corresponding colour before it.

Harman's diaphragm test is a very convenient method for discovering among other things if there is binocular vision. The illustration, Fig. 8, shows how it is constructed. When the patient is looking through the hole with the end of the instrument pressed against his lip some printing is inserted in the carrier. Some of this he sees with his right eye and some with his left, and the central portion with both together. The way in which this is accomplished is shown in Figs. 8, 9, and 10.

Field of Vision.—This represents the area which can be seen by an eye. When we turn our eye on to a certain object we place it in such a position that the macula receives its image, but we see a great deal more than this. The full area which we see is called the field of vision. In many diseases it is smaller than it should be, and it becomes necessary to find out what size it really is, or in what direction the contraction has taken place.

The instrument used to measure this is called a perimeter (Fig. 11). Many forms of perimeters are made, but they all consist of an arc, marked in degrees, which revolves round a centre. On this a white or coloured object travels. The patient sits with his chin on the rest and closes one eye, the other looks at a white object situated in the centre of rotation of the arm, which is so arranged that it is on exactly the same level as the eye which is being examined. The travelling object is first of all put to the extremity of the arc and then gradually drawn in, and the moment it is seen a mark is made on the chart corresponding to the position of the object on the arm.

The arc is then rotated through five or ten degrees and a similar observation is made. This is repeated at intervals until the arc has described the 360° of the circle. The dots made on the chart are then joined together with an ink

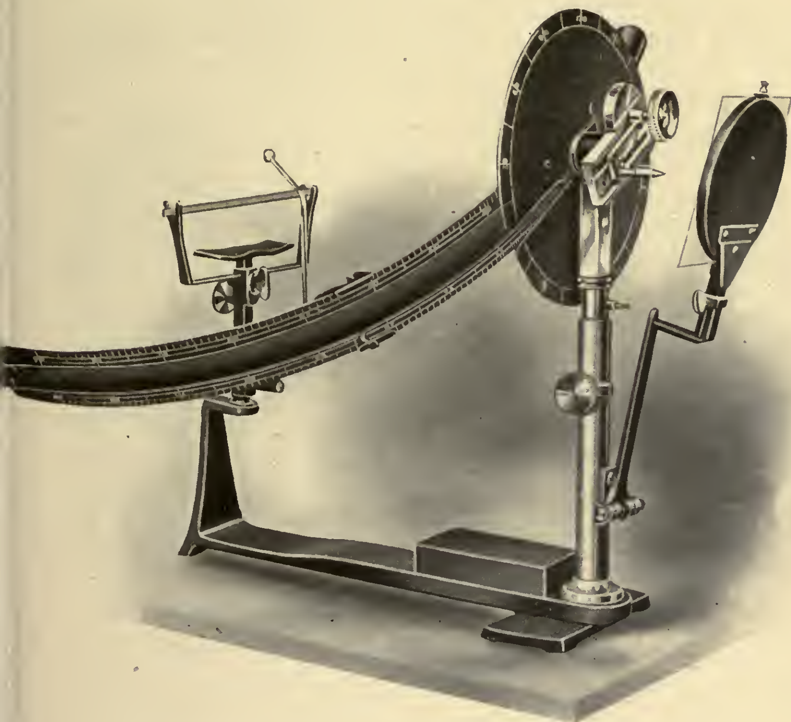
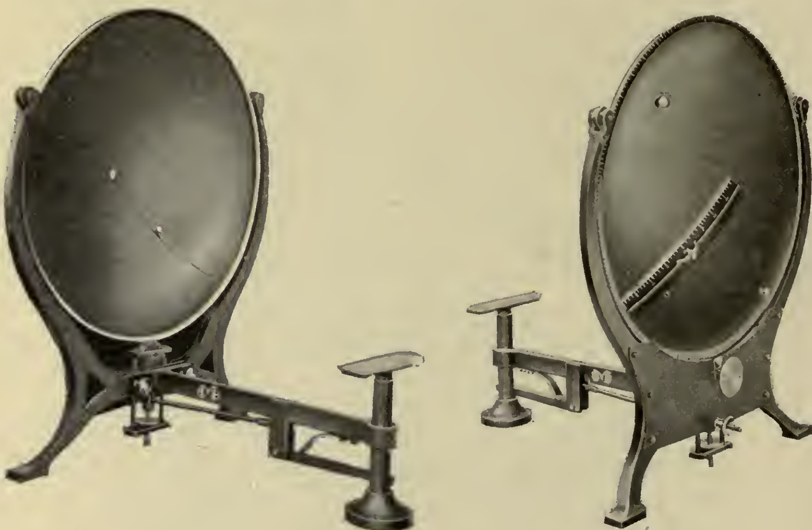


FIG. 11.—McHurdy's perimeter.

line, and we are thus able to see the exact size of the field of vision and compare it with the normal.

Perimeters are of such varying forms that it is impossible to describe them all, but the principle is the same. Most of the best are self-registering, and the same mechanism which moves the traveller in the arc also moves a style at the back of the instrument to a corresponding degree. The chart is fixed in a carrier, when by pushing

it against the style a prick is made; this avoids the necessity of making any calculation as to where to mark the chart. Some perimeters carry as a test object a small electric light, and by substituting a coloured lamp for a white one the field of vision for that colour can be taken. This has the advantage of there being always the same illumination. Care must be taken by the examiner to



(Front). (Back).

Figs. 12 and 13.—Bardsley's scotometer.

watch the patient's eye the whole time, so as to see he is really looking at the white central object, and is not following the traveller with his eye.

Central Scotoma.—A central scotoma, or blind spot, may be readily mapped out on the perimeter. A small coloured object about one millimetre square is shown in the carrier and brought up to occupy the same position as the central white spot previously described. If now there is a central scotoma for colour, the patient will be unable to tell what colour is shown, but if it is removed

slightly from the centre he may be able at once to say what colour it is. Central scotomas for red and green are frequently found in cases of tobacco amblyopia. If there is central choroiditis the scotoma may be absolute for all objects as well as for colours. By rotating the arc of the perimeter and seeing when the object is recognized the whole scotoma may be marked on the chart. It may be more accurately measured by means of Bardsley's scotometer.

A rough but very useful way in which the field may be taken without a perimeter is the following: If the right eye is to be examined the patient is told to close the left eye by holding the palm of the hand in front of it. The surgeon places himself about eighteen inches in front of the patient and closes his left eye, while the two right eyes are on the same level and are looking straight at each other. The surgeon next places his right hand midway between the two faces, but so far towards the temporal side as to be invisible to him; he then brings it slowly in until he can just see it. If now the patient has a normal field, both he and the surgeon will see the hand at the same time; if contracted it will have to be moved further in before it is seen by him. The nasal side is measured in the same manner, and also the superior and inferior portions of the field are tested, or any other meridian which may be desired. In this way a very fair idea of the field of vision can be obtained. In people whose vision is too bad to see the field small central spot in the perimeter this may be the only way in which it can be taken.

CHAPTER II

REFRACTION

Much of the work of a modern ophthalmic surgeon is concerned with the refraction of the eye. It is quite impossible for any one to treat patients successfully for errors of refraction, unless he know a good deal about the eye and the various pathological conditions which show themselves. And conversely it is of the highest importance that any medical man who aspires to a knowledge of ocular diseases should make himself familiar with the many varieties of refractive errors. In order to exemplify the importance of this we have only to remember that no single person who lives much above forty years can fail to require glasses during one period or other of his life. If he be myopic, or short-sighted, he is unable to see well at a distance from his earliest days without correction, and if he be hypermetropic, or even emmetropic, he will find his sight for near objects getting defective after he has arrived at the age of forty or forty-five. The following terms are used to indicate the refractive state of the eye.

Emmetropia is that condition in which all parallel rays are focused correctly on the retina when the eye is completely at rest, and when no effort of accommodation is being made, and thus a perfectly distinct inverted image is formed upon the retina just as in an accurately focused image which is seen on the ground-glass screen of a camera. Such a perfect condition is theoretically possible, but practically no eye is ever free from some small refractive error, and traces of astigmatism may always be demonstarted if looked for, but many of these errors are too small

to require a correcting lens, and such eyes are termed emmetropic.

Hypermetropia is by far the most common error to be discovered in an eye. It is that condition in which the fore and aft diameter of the eyeball is too short, and therefore parallel rays of light are still converging and have not reached their focus when they strike the retina. An indistinct image is thus formed, which can only be made sharp by the use of a convex lens to shorten the focus, or else by an effort of accommodation being made by means of which the lens of the eye is rendered more convex, and thus the refractive media of the eye are increased in power; under these circumstances a clear image is formed. Practically all those people with extra good distant vision are found to be hypermetropic to a certain degree, but such eyes in their uncorrected state are not the best suited for near work owing to the excessive amount of accommodation required before such can be focused.

Myopia, or short sight, is that condition which is the reverse of hypermetropia. The fore and aft diameter of the eyeball is too long, consequently the rays of light meet at a point in front of the retina, and have thus crossed and are diverging before they fall upon it, just as if the ground-glass screen of a camera were set too far from the lens and behind its principal focus. An indistinct image is thus formed, which can only be made sharp by placing a concave glass in front of the eye and thus throwing the focus further back. Although every eye which possesses accommodation can bring the image further forward, and thus in hypermetropia focus it correctly, yet the eye contains no mechanism by means of which it can lengthen the focus, therefore all distant objects are indistinct and must remain so to a myope unless a suitable lens be supplied. It should be remembered that a hypermetropic eye of, say, 3D, and a myopic eye of the same degree, have equally indistinct vision at a distance; but the former by an effort of his accommodation can

overcome his error, whereas the latter cannot. Were it not for the accommodation both eyes would see equally badly, but the nearer an object approached the myopic eye the clearer it would become, but the nearer it approached the hypermetropic eye the less distinct would it be. This is a very important point to be grasped and remembered.

Astigmatism is a variety of either hypermetropia or myopia, and it is usually caused by the curve of the cornea being greater in one diameter than in another, as in the case of an oval body when the curve of the long diameter forms an arc of a much larger circle than does the curve of the short diameter. Obviously this will give rise to an indistinct image, and whether the curve is too great in one diameter or too little in the other, astigmatism is produced.

Astigmatism is divided into two large groups—*Regular* and *Irregular*. The former is the variety with which we are almost entirely concerned in refractive work, and this large group of cases is divided into the following sub-divisions :—

(*a*) Simple Hypermetropic Astigmatism: that is, when the curve of one diameter of the cornea is correct and the one at right angles to it is hypermetropic.

(*b*) Compound Hypermetropic Astigmatism is that condition in which the whole eye is hypermetropic, but one meridian is more hypermetropic than the other.

(*c*) Simple Myopic Astigmatism is the condition when one meridian is emmetropic and the other is myopic.

(*d*) Compound Myopic Astigmatism is the condition when the whole eye is myopic, but in which the myopia is greater in one meridian than in the other.

(*e*) Mixed Astigmatism is that condition where one meridian of an eye is hypermetropic and the other is myopic.

Note.—It should be remembered that in all cases of regular astigmatism the meridian of greatest curvature is at right angles to the meridian of least curvature, just as in the case of any oval body.

Irregular Astigmatism is usually produced by scars of wounds or ulcers, when the density of the cornea varies at different parts. It is impossible to grind a lens which will correct it. This condition gives rise to very serious defect of vision, far more due to the irregular astigmatism than to the actual blurring caused by the nebula. Even so simple a condition as a phlyctenular ulcer in childhood may be the cause in later life of the patient failing to pass the eyesight test for some public service.

Measurement of Visual Acuity.—Before one is able to ascertain what the patient's vision really is, it is necessary to have some standard which is more or less in general use. The almost universal test for vision is Snellen's type,

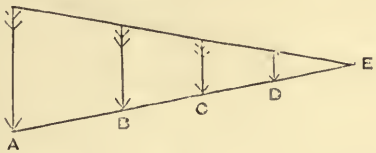


FIG. 14.

or some modification of it, and the principle on which it depends is this: it is assumed that a healthy eye is capable of distinguishing a letter which subtends an angle of 5 minutes on his retina, and that each part of the letter shall subtend an angle of 1 minute. These angles can be easily measured with a sextant and a card of test types.

It is a matter of indifference how far the patient is standing away from the object, provided that when it reaches his retina the correct angle is formed (Fig. 14).

Thus, for instance, suppose the whole distance from A to E were 60 metres, from B to E 36 metres, from C to E 12 metres, and D to E 6 metres, and that the angle made at the point where the two converging lines meet is 5 minutes; now precisely the same angle is made by the large arrow at 60 metres distance as by the small arrow at 6 metres, and if we were to represent it as a fraction we could say

that if a patient saw at 60 metres what he ought to see at 60 metres, his vision is $\frac{60}{60}$.

However, most consulting-rooms are nothing like so long as that, so 6 metres is the distance which is usually taken. Now if a patient standing at 6 metres from the board containing the letters sees what he ought to see at that distance, we can represent his vision as being $\frac{6}{6}$. If, however, he only see at 6 metres what he ought to be able to see at 60, we call his vision $\frac{6}{60}$. The numerator of the fraction always indicates the distance at which the patient is standing from the object, and the denominator signifies the letter he is able to see. The letters are usually graduated thus:—

The letter marked 60 is the largest. Then comes one half its size marked 36, then follow 24, 18, 12, 9 and 6, and most boards contain still smaller letters marked 5 and 4. Now if a patient has still better than what is considered to be normal acuteness of vision, or $\frac{6}{6}$, we may express it as $\frac{6}{5}$ or $\frac{6}{4}$, meaning that he sees at 6 metres what the normal-sighted should see only at 5 or at 4 metres, therefore his sight for distance is above the normal. Most long-sight people can see $\frac{6}{5}$, and some more still, so that $\frac{6}{6}$ is not a very high standard; but any one seeing that would fulfil the requirements of the most exacting of public bodies.

Suppose the surgeon does not possess a room 6 metres long, he can just as well work at a distance of 5 metres or even 4, but he must have smaller letters printed, so that he has a line representing $\frac{5}{5}$ and $\frac{4}{4}$, and either of these represents the same visual acuity as $\frac{6}{6}$. He must, however, remember that $\frac{5}{18}$ or $\frac{5}{12}$ or any other fraction when the numerator and denominator are not equal are very different from $\frac{6}{18}$ or $\frac{6}{12}$, etc., for the patient is one metre nearer the object letters which are the same size. A person who could see at 6 metres what he ought to be able to see at 18 metres would obviously have better sight than one who could only see at 5 metres what he ought to be able to see at 18 metres, and so on (Figs. 15 and 16).

Testing Near Vision.—A patient's near vision is usually tested by the graduated types of Snellen or Jaeger.

Jaeger's types are simply numbered from 1, which is diamond type, to 20, which consists of very large letters.

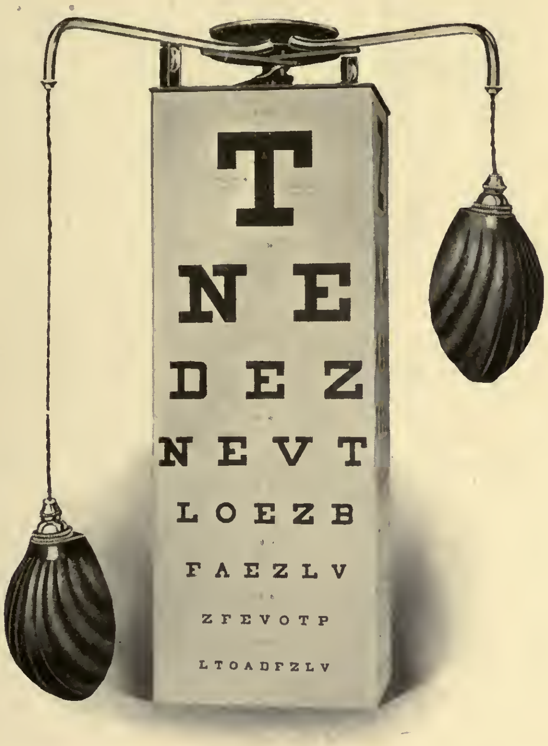


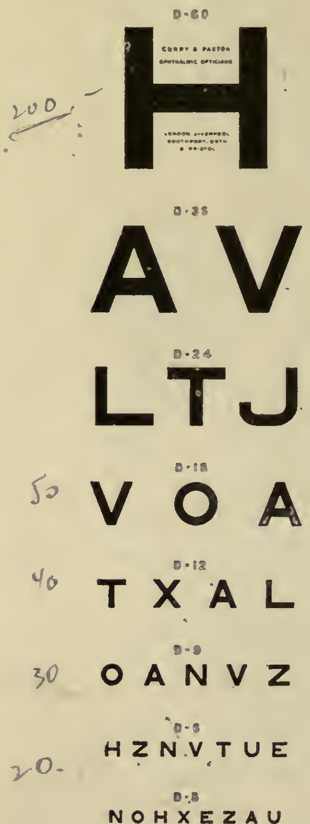
Fig. 15.—Test types reduced in size, showing method of illumination.

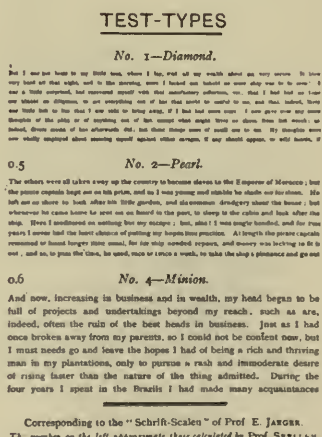
Snellen's types are numbered somewhat differently, and it is matter of indifference which are used.

It is usual to represent a patient's near vision as being J 1 or 6 or any other number, and if Snellen's types are used, Sn. ·05 or 1, etc. (Fig. 17).

Mydriatics.—The chief difficulty in coming to a correct

conclusion as to the refractive state of the eye is caused by the accommodation. In a young child this amounts to about 14D, so that at will he is able to alter his refraction to this extent. However, the power of accommodation is





Figs. 16 and 17.—Test types, considerably reduced in size.

a gradually diminishing quantity from childhood to old age, and by the time a person has reached forty-five years of age he has only about 4D left. If now it is the accommodation which causes trouble it is obvious that the greater the amount of it that a person has, the greater will

be the confusion to which it may give rise. Although the ciliary muscle is under voluntary control, yet it requires a good deal of practice for any one to be able to relax it at will, especially if he happen to be looking at a near object. It may be taken for granted that children are unable to relax the muscle, therefore if relaxation is desirable it becomes necessary that atropine or some cycloplegic be used, which not only dilates the pupil, but also paralyses the ciliary muscle or muscle of accommodation. If this be done it becomes a comparatively simple thing to work out the refraction, for it virtually means that the glass the patient can see best with at a distance is correct. Near vision cannot be satisfactorily tested when the eye is under a mydriatic, for the patient then has no accommodation, and the glass he requires varies with the amount of accommodation. It is, however, next door to impossible to correct a refraction case by simply allowing the patient to select the glass he sees best with, and it becomes essential for the surgeon to devise a method whereby he is able to ascertain from his own observations what is the refraction of the eye under examination.

From what has previously been said it will be obvious that the younger the patient the more necessary it is to use atropine before working out the refraction, but the older he becomes the less is it required.

It may be stated as a general rule that atropine is essentia in all people up to about sixteen years of age. It is very desirable in many up to about twenty-five years. After that the majority can be worked out quite well without a mydriatic. After thirty or thirty-five years of age it is not necessary to paralyse the accommodation, for by this time the amount the patient possesses is so small that it is nearly always under control, and if the eye be directed to a distant object in a dark room, the pupil will dilate and the ciliary muscle will relax quite sufficiently to allow of everything necessary being done. It should be remembered that these remarks do not apply

to the dilatation of the pupil which is often required in people of any age for purposes of ophthalmoscopic examination, but the surgeon should never dilate a pupil in an elderly person without real necessity, as it is liable to cause an attack of acute glaucoma in an eye which may be already predisposed to the disease, and also in most cases the fundus can be quite well examined through the undilated pupil. In addition the glass required for near work cannot be ascertained if the eye is under the influence of a mydriatic.

In any case suspected of having an error of refraction the following routine should be gone through in order to ascertain what it is and how it should be treated.

In all cases in which a patient is old enough to read letters, his vision should be taken at a distance *with each eye separately*, and this is at once recorded. If the patient is a child, atropine drops or ointment 1 % should then be ordered to be used three times a day for three days. (The ointment is perhaps rather less liable to produce toxic symptoms than the drops.)

Some surgeons use atropine for a week or even longer, but it is scarcely ever necessary to do so, and poisonous symptoms are liable to be produced by its prolonged use. When next the child is seen a retinoscopy is done and the result carefully noted.

If the child is old enough it is useful to test him at the types, and see what his vision is with the glasses which are indicated by the dark-room observations. Then after allowance has been made for the atropine the glasses which it is intended the patient shall wear are ordered. Sometimes a patient is told to make a third visit in order that the sight may be tested after the effect of the atropine has passed off, the surgeon, however, should never allow his judgment to be too much influenced by what a child tells him, but should order the glasses he *knows* to be correct as the result of his retinoscopy.

If a child has never seen well owing to a refractive error,

and perhaps scarcely knows his letters, it is useless to take notice of what he says he can see with glasses. If astigmatic he has never seen objects and lines except in a distorted condition, and he is utterly unable to appreciate the fact that with his correction he sees them as they really are, for naturally he thinks they are wrong when they appear to be different from what he has always known them to be. Infinitely fewer mistakes would be made if the surgeon were to rely on his own work and order what he considers to be correct, rather than let his judgment be influenced by what a child tells him. It is all very well to prove his work, but it should not modify his prescription except in a very minor manner.

If the patient be older, and able to explain how things really appear, then his answers may be of considerable value. In this case we perhaps give atropine as before, and the examination is conducted in a manner exactly similar to that described above. Now, however, it is very useful to take the patient to the test types and see how near one's correction is to the glasses with which the patient sees best. If there is astigmatism present one frequently gets useful hints as to the exact position at which the axis of the cylindrical lens should be set.

Sometimes the astigmatic fan or clock is brought in to help. Owing to the fact that the pupil is dilated, it often happens that the patient's vision is not quite normal, and we frequently get a better result after the effect of the atropine has passed off. In order to overcome the effect of the dilated pupil while the vision is being tested, it is useful to use a diaphragm and make the patient look through a round hole of about two millimetres in diameter. However, if good vision is obtained with the glasses which correspond to the retinoscopy correction, there is no need to see the patient again after the effect of the mydriatic has passed away, but 0·75 or 1·0 D should be taken off a + or added on to a − lens to allow for the atropine, and the glasses are at once ordered.

It is always possible as the result of retinoscopy to ascertain the axis at which the cylinder is required, but there is no harm in moving it about a little in the frame until the patient obtains the best vision. This will scarcely ever be found to be more than a few degrees different from what one found in the dark room, but the stronger the cylinder the greater is the necessity for absolute accuracy in the prescription.

In all cases of refraction let this fact be strongly impressed upon the surgeon, viz. that the best correction consists in giving the highest + (convex) glass and the lowest − (concave) glass with which the patient can obtain normal vision. It is obvious that if a patient who has still some accommodation can see $\frac{6}{6}$ with, say, + 4, he will equally well see it with + 3, and perhaps with no + glass at all; but if he is unable to see it with anything stronger than + 4, this should be ordered. And conversely, if a patient can see as well with a − 2 as he can with a − 3 or − 4, but cannot get normal acuteness of vision with less than − 2, this should be taken as the correction. It is impossible to over-correct a case of hypermetropia without knowing it, for if this be done the distant vision is reduced, but nothing is easier than to over-correct a case of myopia, for the patient will use his accommodation and still see quite well with the glass, but it will cause pain and head-ache if worn, and may very likely induce the eye to become more myopic, therefore the greatest care is necessary.

Presbyopia.—This condition is entirely different from the other errors of refraction which have been described. Most emmetropes find that after about forty to forty-five years of age reading and near work is not so easily seen as it was, although distant vision is as good as ever.

They first of all notice that when the light is not very good they are unable to see fine print, and objects have to be held further away than was formerly the case. Now this condition is entirely due to a failure of accom-

modation; they have not so large a range as they had, and consequently divergent rays which reach the eye (as from a near object) are not correctly focused on the retina. It will thus be seen that it is not due to any alteration in the refraction of the eye but purely to loss of accommodation.

Now how is this condition brought about? A child starts life with a large amount of accommodation to his credit, and when ten years of age he possesses about 14 dioptres. From that time, and before too, the amount of accommodation gradually diminishes until a patient is about sixty-five or seventy years of age, when he has none left. For ordinary near work such as for reading, about 4D are required to be added to the emmetropic eye, and so long as a patient possesses from 4·5 to 5 D he is quite able to read and do near work without discomfort, but as soon as ever he requires to use every particle of accommodation he has, the effort is too great and the eye cannot sustain it with any degree of comfort, therefore some outside help is required; and although he is able to see for a short time if the light be good, and especially when fresh after a night's rest, yet the difficulty becomes more marked as the day advances and the eye gets tired.

Presbyopia is a natural consequence of the structure of the lens of the eye. It will be remembered that when the eye was developed a portion of epiblast was cut off to form the lens, and this consisted of epithelium.

Like all epithelial structures it continues to grow, but unlike most others it is confined in an enclosed space (the lens capsule), and consequently it cannot shed its superabundant cells like, for instance, the epithelium covering of the skin, which is no thicker at one period of life than at another, except as the result of friction and local causes. When the lens fibres proliferate there is no escape for them, and consequently they have to pack themselves closer and closer together, and this renders its structure harder and more dense. In early life the lens resembles jelly, but

in old age it is so hard that it is difficult to alter its shape.

It will be remembered that according to the more generally accepted view, the suspensory ligament of the lens is always tightly stretched across the anterior surface of the lens, but that when the ciliary muscle contracts it is slacked, and the natural elasticity of the lens causes it to become more convex, and consequently it has a greater refractive index, and is able to focus diverging rays of light on the retina. If, however, it is so dense that it cannot bulge in spite of the suspensory ligament being relaxed, no effect is produced upon its refractive power. It will thus be seen that a baby will have a greater amplitude of accommodation than an older child, and a person at ten years of age will have more than one at twenty or any older age, and so on, until we find that at about forty-five a patient barely has 4D left, and at sixty-five or seventy he has lost even this.

So long as a patient retains a little more accommodation than he really wants he can get on quite well without reading glasses, but as soon as he loses more than this he finds himself in a difficulty.

We saw, when treating of hypermetropia, that such a patient required a greater or less amount of accommodation in order to see even distant objects, and it is obvious that he will require still more in order to see near things. For example, suppose a patient has 2D of hypermetropia to begin with, he will require to use this in order to see his distant objects correctly, and he will require about 4D more in order to read, therefore he will always for near work require 6D of accommodation if his hypermetropia remains uncorrected. By the time he reaches the age of thirty-five or thirty-seven he will only just have this amount, and consequently he will be in the same difficulty with regard to reading as the emmetrope will be eight or ten years later. However, at this age it is only necessary to order the full correction for the hypermetropia, for if we give him

his + 2D glasses, he still has his 6D of accommodation left, and these will last him until he is about forty-five years of age, when he will require a further correction of + 1 being added to his hypermetropic correction and then he will require + 3 for reading instead of + 1 only, as he would do if he were emmetropic.

On the other hand, the myope of 2 at the same age will not require more than 2D of accommodation in order to read with, for his myopia will supply 2 out of the 4 required. He, therefore, will find no difficulty in reading until he has lost all but 2D of his accommodation, and this will not occur until he is from fifty to fifty-five years of age; and suppose he had as much as 4 or 4·5 D of myopia, he would always be able to read without glasses no matter how old he was, because, having this amount, his eyes would be permanently adjusted for near objects, and consequently he would never require his accommodation, and the fact of its having ceased to exist would not be noticed. Still the condition which causes presbyopia, viz. the loss of accommodation, is present in every eye, and if the distant vision be corrected for hypermetropia or myopia, and thus these eyes are rendered emmetropic, we shall still find that the hypermetrope will require a stronger + glass for reading after forty-five years of age than he requires for distance, while the myope at the same age will require a proportionately weaker glass for the same purpose.

That some people are known to arrive at old age and are still able to see to read without glasses is a fact which is generally recognized and known by the patient and his friends, and not infrequently we hear it stated with pride that a certain elderly person is still able to read without glasses, while another who is perhaps thirty years his junior is quite incapable of seeing a word without them. The former is thus popularly supposed to have very strong eyes, the fact is often stated to prove what a very vigorous man he must be. In reality, however, it only proves that he is a myope, and has probably never had

anything like normal distant vision; but that is frequently forgotten, especially by his friends, who still hold that he must have far stronger eyes than some one else who requires glasses. If, however, as sometimes happens, the patient, after having used reading glasses for some years, suddenly discovers he can see quite well without them, it almost certainly points to the fact that his lenses are swelling, and that they are on the verge of becoming cataractous.

It is due to the facts above described that the popular superstition is based, viz. that a short-sighted eye is a very strong one and lasts the longest. The exact reverse is the fact. Myopic eyes are subject to all sorts of diseases which are practically never seen in others, and it would be far more correct to look upon them as being the weakest eyes of any. Myopia is certainly not a condition to be desired. Distant vision in such a person has never been up to the normal without glasses, and he should have worn them all his life, whereas the hypermetrope of low degree has for the first fifty years or so of life had perfect distant vision, and until about forty, or even later, he could still see near things without glasses if necessary, but after that glasses are absolutely necessary for near work and of course they are desirable long before.

Presbyopia requires correcting as soon as near work becomes difficult, and as we know roughly the rate at which the accommodation fails, so we can draw up a scale for the presbyopic correction required at any time.

A useful working rule is as follows, which, though not strictly accurate, yet it is so easy to remember that it is worth noting. It simply consists of adding 1D to every five years the patient has lived between the ages of forty-five and sixty; thus—

At 45	years	of age	the patient	requires	+ 1D	for	reading
,, 50	,,	,,	,,	,,	+ 2D	,,	,,
,, 55	,,	,,	,,	,,	+ 3D	,,	,,
,, 60	,,	,,	,,	,,	+ 4D	,,	,,

The error in this simple rule is that the correction is rather too high. A person at forty-five usually requires + 1D; at fifty he would probably prefer + 1·75; at fifty-five + 2·5 would perhaps be better than + 3; at sixty most people prefer + 3·5 instead of + 4; and if we just remember that these figures all err on the side of being rather too high for the majority of people, we shall have no difficulty in knowing what is usually required, though there are many people who will take the full corrections; so much depends upon the actual work for which the patient requires it. Thus for an engraver or a miniature artist it would be by no means too high a correction, perhaps not quite high enough; but for a carpenter or one used to doing quite large work it would be vastly too much, while it is rather on the high side for reading and writing.

It must never be forgotten that the presbyopic correction must be added to any hypermetropic correction and subtracted from any myopic correction required. It is, therefore, impossible to prescribe a presbyopic correction for any one without first of all ascertaining whether there is any manifest hypermetropia. With a person at the presbyopic age the highest + glass with which he can obtain the best vision may be taken as representing the correct amount of hypermetropia present.

In order to find out the manifest hypermetropia the patient should be placed at six metres off a test type, and a glass put in which is certain to over-correct his error. Then concave glasses are put in front of it and their strength gradually increased until normal vision (if possible) is produced. If, say, we put up a + 4 lens and we find we had to place − 2 in front of it before we could get $\frac{6}{6}$, that would mean he had 2D of manifest hypermetropia. If we put a + 2 glass up first he would probably not accept it, because he would not have had time to get his ciliary muscle relaxed.

CHAPTER III

DISEASES OF THE EYELIDS

THE eyelids being composed of loose tissues are very subject to œdema from any slight cause such as a small boil, a wound in the neighbourhood, a bite from an insect, etc. For the same reason hæmorrhage may take place into the subcutaneous tissue of the lids and cause much discoloration, hence the familiar "black eye." Intense swelling is occasioned by erysipelas of the lid, or in fact by any inflammatory condition of the head or face.

In order to understand the various pathological conditions to be described, the anatomy of the lid must be borne in mind. It consists of skin, subcutaneous tissue, tarsus, submucous tissue, and conjunctiva, while the glandular development in it is extensive. Besides the ordinary glands of the skin and conjunctiva, there are the Meibomian glands, the glands of Moll, and the large hair follicles from which the eyelashes grow. Situated on the lid margins are the upper and lower canaliculi, or the openings into the lacrimal sac, and besides all these there are numerous conjunctival glands which secrete mucus or watery fluid, and which have such an important part in keeping the corneal surface moist and healthy. The lacrimal gland also is situated at the upper and outer part of the orbit, and its ducts open on the conjunctival surface of the upper lid. Considering all these many structures it may readily be understood that the diseases of the eyelids are numerous.

In addition to these there are the congenital abnormalities. The most important of these is *congenital ptosis*, and this is due to defective development or complete absence

of the levator palpebræ superioris. The lid may almost completely cover the cornea, but as a rule some power is present by means of which the eyelid may be raised. Sometimes one upper lid only is affected, at other times both are involved, and when this is the case the patient assumes a very characteristic attitude. He walks about with his head thrown back, otherwise he is unable to see anything that is at all above the level of this eyelid. By using the occipito-frontalis a little elevation of the eyelid is possible.

Ptosis is not always congenital, for paralysis of the third nerve will produce much the same condition. Although paralytic ptosis may altogether disappear by using measures to cure the disease which causes it, yet the congenital variety never improves, and it is usually necessary to do some operation for its relief. All sorts of ingenious methods have been devised, but it is not possible here to go into the details of them. Most of them have for their object the hitching up of the lid to the frontalis muscle, so that by its contraction the lid is raised. In Mules's operation wires are used to effect their junction; these are buried and remain there permanently. Harman recommends very fine chain for the same purpose, while Worth uses kangaroo tendon. Hugo Wolff endeavours to find the ill-developed tendon of the levator palpebræ, and by advancing this he shortens it up and thus it becomes more efficient. For details of these various operations, which are not often required, a book on operative surgery must be consulted.

A curious condition often accompanying congenital ptosis is associated movements of certain muscles which have nothing to do with each other normally. Thus when the eye is abducted the lid may be raised, when it is adducted the same thing may happen, and also the lid may be raised when the mouth is opened. Sometimes the lid is raised when the pterygoid muscles are thrown into action.

Epicanthus.—This is a condition present normally in

the Mongolian races, and consists of a crescentic fold of skin between the nose and the inner canthus. The appearance is peculiar and it may be improved by operation.

Congenital Coloboma of the upper lid is rarely seen, and is often associated with other congenital defects, and perhaps the presence of a dermoid tumour. A plastic operation may be undertaken for its relief.

Chronic Ciliary Blepharitis, or Marginal Blepharitis.—This is one of the commonest conditions of the eye. It occurs very frequently in children, especially in those who are delicate and who are liable to suffer from phlyctenular conjunctivitis. Small pustules form at the root of the eyelashes and cause irritation of the glands with hypersecretion. In a mild attack an eczematous condition is produced with much dry secretion along the edges of the lids, which makes many of the eyelashes adhere into one matted mass. If it is more severe, ulceration of the lid margin supervenes. In even the slighter cases the eyelashes become shed, but in the more severe forms the hair follicles are destroyed and the lids become bald.

Large scabs adhere to the lid margins, and every time they are removed some of the loose eyelashes come away too. The ulceration may be so severe that the lids are permanently scarred and deformed, and will be a disfigurement during the whole of life. In these neglected cases the lid margins turn inward, and if some hair follicles escape the lashes will irritate the cornea and produce trichiasis.

The cause of the disease is the staphylococcus, and as this organism gets deep in the lid it is often extremely difficult to cure. In many of the cases there is a refractive error present which helps to keep up an irritable condition of the lids.

Treatment.—The disease can always be cured if it is taken in its early stages, but after once the hair follicles are destroyed and the lid scarred, a permanent deformity is inevitable.

All scabs and dried discharges should be carefully removed with some simple lotion such as bicarbonate of soda or potash of gr. x ad ℥j. Care should be taken to remove any trace of a scab, and the eyelashes must be washed perfectly clean so that no matting of the individual lashes remains.

Should there be an ulcerated surface beneath the scabs, this should be carefully painted with nitrate of silver 1 or 2 %, or touched with the mitigated stick. Pure nitrate of silver should not be used, as it is too strong and causes unnecessary injury.

After the lids are clean yellow oxide of mercury ointment of about gr. iv ad ℥j should be well but gently rubbed in. Ung. hydrarg. ammoniati 1 to 2 % is also very useful; so also are many other mild antiseptic ointments. Care should be taken to attend to any abnormal conjunctival or lacrimal condition which may be present, and any error of refraction should be corrected.

Should the lids be very bad and the child troublesome so that it is difficult to efficiently do what is required, it is quite worth while to give a general anæsthetic; it is often astonishing what good results are obtained in this way. It sometimes happens that in spite of all care the eyes do not get well. If this is so, then X-rays should be applied, but only by an expert who knows exactly what he is doing and the dose he is giving. The rays are applied exactly like they are for ringworm. If the proper exposure is given the old lashes will be shed, the staphylococci in the hair follicles will be killed, and healthy lashes will take the place of the diseased ones. Owing to the fact that very dangerous burns may result if the exposure is too long, and no good will be done if the exposure is too short, no one but an expert should attempt to use this very powerful but very useful therapeutic agent. It is possible that radium may act in the same way.

Phtheiriasis Ciliorum is due to the pediculus pubis, and is only likely to occur in very dirty and neglected people,

chiefly children. It causes intense irritation, and the ova can be seen adherent to the eyelashes, and often the lice themselves may be found lodged between the cilia.

Treatment.—The lids should be washed with perchloride of mercury 1/4000, and then a mercurial ointment must be rubbed in, such as ordinary blue ointment, ammoniated mercury, or yellow oxide of mercury. These cases are quickly cured.

Syphilitic Affections of the Eyelids.—This may occur as a primary, secondary, or tertiary lesion. A primary sore or hard chancre is sometimes seen on the eyelid and may occur wherever the seat of inoculation happens to be. At first it appears as an indurated pimple which breaks down and produces a clean-cut ulcer. It may have an appearance very like a broken-down epithelioma. The preauricular and submaxillary glands are always enlarged, as they are in many other ulcerative conditions. Owing to the extremely infective nature of the disease the greatest care must be taken that neither the surgeon nor the friends of the patient become inoculated.

Fig. 18.—Primary syphilitic sore of upper lid (hard chancre).

Treatment.—The sore should be washed with Lotio nigra, calomel dusted on, and general treatment for the disease should be commenced.

Secondary Syphilis sometimes affects the lids in much the same way as it affects the skin and mucous membranes in other places; ulceration of the lid margins with destruction of the lashes may occur.

Treatment.—Mercurial ointment and lotion may be used

locally, and general treatment must be carried out vigorously.

Tertiary Syphilis usually appears in the lids as a tarsitis. There is a gummatous thickening of the lids, while the tarsus itself is much infiltrated and thickened.

Treatment.—Local treatment is not of much use, but iodide should be given internally, and it may with advantage be combined with mercury.

Vaccine Inoculation.—A nurse may get her eyelid inoculated from a baby who has been vaccinated. It produces a characteristic vesicle with œdema of the surrounding parts and much pain and irritation. It cures itself in about a week, but it may have caused destruction of some of the eyelashes. As a rule it does not lead to permanent trouble.

Herpes Zoster Ophthalmicus, or Shingles.—This is a serious affection of the first division of the fifth nerve, though sometimes the second division, and still more rarely the third division, are also involved. Before the appearance of the vesicles on the skin there are usually severe neuralgic pains about the forehead, and this is soon followed by febrile symptoms with a development of vesicles which follow the distribution of the supra-orbital nerve. The infra-trochlear branch is often affected too, and this gives rise to vesicles on the side of the nose, and not infrequently on the cornea itself. Conjunctivitis and serous iritis are sometimes developed.

The number of vesicles varies considerably. Sometimes there are only half-a-dozen or so on the forehead; at other times they are far more numerous, and extend back along the scalp to the occipital bone. The vesicles may be so numerous that they become confluent, but in any case they will be accurately limited to one side only, and will not overlap the middle line. This is most characteristic and diagnostic of the disease. The inflammation may be so intense as to resemble erysipelas, for which it is frequently mistaken by those not acquainted with the disease. A mistake can

never be made if it be remembered that the only part affected is that supplied by the first division of the fifth nerve *on one side.*

The vesicles soon become purulent, after a few days they burst and leave small ulcers behind, which on healing appear red and subsequently white just like any other scar. The scars are pitted as in the case of small-pox. If they are numerous, and have become confluent, one half of the forehead and the corresponding part of the scalp may have the appearance of one huge scar much like a burn. The eyebrows may be partially or entirely destroyed, and although there may be severe neuralgic pains over the affected area, yet the skin is numb or anæsthetic.

By far the most serious results occur when the cornea is involved, but this seldom happens unless the nasal branch of the nerve is affected. Owing to trophic changes the cornea may be unable to retain its vitality and may slough, or the ulcer may be so extensive that it leaves a large leucoma behind and practically destroys the sight of the eye. Sometimes a limited keratitis without ulceration develops. It mostly comes on in elderly people and causes serious constitutional disturbance.

Treatment.—Very little can be done locally to the skin. Any soothing ointment such as boracic and cocaine $\frac{1}{2}\%$ may be applied. If the cornea or iris be affected, atropine should be used; but, more important than all, the eye must be kept closed. The cornea will probably be anæsthetic, and any particles of dust or other foreign bodies settling on it will not be felt, and great damage may thus be done owing to its feeble state of nutrition due to the involvement of the trophic fibres of the nerve. The general state of the patient is usually much affected, and it is as well that he should be kept in bed, or at least indoors, so long as any febrile condition is present. Quinine, bromide and phosphate of zinc may be given internally, and the eye should be well, but very carefully, washed out with bisulphate of quinine lotion gr. iij to ℥j, atropine

should be used if there is any tendency to iritis. The cornea may remain affected and pain may continue for months, but after a time the symptoms disappear.

Rodent Ulcer usually affects the skin about the eyelid or in its immediate vicinity. It commences as a small raised spot which elevates the skin but does not at first cause ulceration. This is the stage in which it should be recognized, for it is quite easy to cure it before ulceration has commenced, but a very different matter if it has extended widely. If left alone the surface will break, and a scab will form which can easily be removed or accidentally wiped off when a small ulcer is seen beneath it with hard and indurated edges. It then begins to spread in one direction, and will very likely heal in another, so that a good deal of scar tissue may be present, but the ulceration always travels faster than the healing process, so that the raw surface is constantly tending to get larger. The chief characteristic of the disease is its extreme slowness of growth, so that there is plenty of time to attack it and cure it if only the serious nature of the disease is recognized. When quite small it may for a time entirely heal, but only to break out again. As a rule, it goes deep as well as superficial and erodes and eats away the bones of the face, orbit, and skull, and will certainly destroy the eyeball in time. So extensive is the ulceration that the skin of the head and face may be almost entirely destroyed, and the nasal passage and the sinuses of the skull may be open, and at last septic meningitis or exhaustion will put an end to the patient's sufferings. The growth is essentially an epithelioma starting in the sebaceous glands of the skin. It differs in almost every respect from epithelioma of the skin. Rodent ulcer lasts for years—twenty or thirty or more; and although it is locally very malignant, yet it never gives rise to metastatic growths.

Treatment.—This has been altogether revolutionized of late years by the discovery of radium. Place a tube containing a few milligrams of radium in contact with the

rodent ulcer for a certain number of minutes, and at certain intervals, entirely according to the radio-activity of the tube, and in the course of a few weeks, and perhaps after only three or four applications, the whole of the growth will disappear and leave no scar or mark behind it, unless, of course, there has previously been ulceration; if there has, it will entirely heal with a small, flat scar.

Should radium not be available the small growth or ulcer may be burnt out with carbonic acid snow, and excellent results are thus obtained, the sore heals well. If neither of these things can be done it should be excised, and the incision should go well wide of the disease both in superficial extent as well as in depth. If only the disease is thoroughly removed it will be cured, but half-measures are altogether useless. The awful cases which were commonly seen only a very few years ago have now entirely disappeared, for all that is necessary is to recognize them in their early stage, and if possible treat them with radium, but if not get rid of them somehow as above indicated. It takes years of neglect and bad treatment for these cases to get out of hand and to spread beyond all hope of cure.

Hordeolum.—This is the common stye, and is caused by infection of a follicle of an eyelash with the staphylococcus. The follicle first of all gets inflamed, swollen and painful, with considerable œdema of the eyelid, and perhaps some chemosis of the conjunctiva. Pus then forms and tends to point at the base of the eyelash. If left alone the small abscess bursts and discharges itself, and the symptoms rapidly subside. Frequently they are multiple, and, like boils, they often come one after the other in rapid succession.

Treatment.—The first thing to do is to pull out the affected eyelash, which opens the abscess cavity; the pus can then be squeezed out. Hot bathing will quickly do the rest, and in order to assist in destroying any living organisms, yellow oxide of mercury ointment gr. viij ad ℥j should be rubbed into the bases of the eyelashes. If

the abscess has to be opened, great care must be taken not to notch the margin of the lid.

Chalazion, often spoken of as tarsal cysts, or Meibomian cysts or tumours, are of very frequent occurrence, and start as an inflammation in one of the large Meibomian glands of the upper or lower eyelids (Fig. 19). Like hordeola they are often multiple, and frequently come one after another, and vary considerably in size. Some are no doubt due to retention of secretion in the gland, but the majority form a solid or semi-solid tumour which, on microscopic examination, is seen to be composed of granulation tissue. The majority are rather gelatinous, and when incised the soft contents can be easily squeezed or scraped out. Frequently they break down and suppurate, and thus form abscesses in the lid. Certain micro-organisms can usually be found in them, but it is very doubtful which, if any, causes the disease. If it be remembered that the Meibomian glands lie immediately beneath the conjunctiva, and that they open well within the lid margin, and at a very appreciable distance behind the hair follicles, there is never any difficulty in distinguishing a chalazion from a stye.

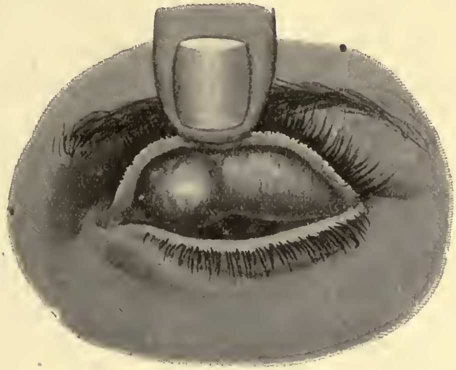


Fig. 19.—Chalazion of upper lid.

Treatment.—If the gland only be inflamed, hot bathing will probably suffice to cure the condition, but should there be a definite granulation tumour inside it will have to be incised and turned out. If it has gone on to suppuration the abscess must of course be opened.

Sometimes they cause so much swelling of the eyelid that one is apt to be tempted to open them from the skin

surface. This should very seldom be done, for however near the growth may be to skin, it is always nearer the conjunctiva, as the gland in which it started is only just beneath it. If the tumour be opened from the skin surface, the whole thickness of the lid will have to be cut through before the seat of the mischief is reached. In addition, cocaine will anæsthetize the conjunctiva, but it is of no use putting it on the skin, and very likely a general anæsthetic will have to be used, or severe pain will be caused. In opening the growth the lid must be everted, and if necessary held with a pair of Graddy's forceps (Fig. 28) or a clamp (Fig. 20). With a very sharp knife an incision must be made into the growth at right angles to the lid margin and never parallel to it, or Meibomian glands will be cut across. The contents can then be expressed, or the cavity may be scraped out with a sharp spoon. The greatest possible care must be taken not to cut the edge of the lid with the knife; if it is, the very slightest incision will make an ugly gaping V-shaped notch, which is most conspicuous for ever afterwards. The seat of the mischief is much further back, therefore the incision should stop considerably short of the lid margin.

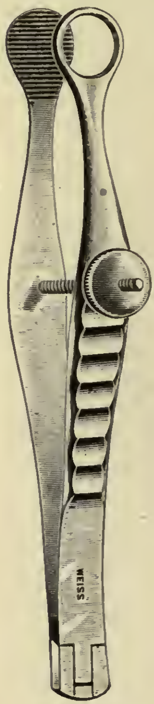


Fig. 20.

Various skin affections such as Xanthelasma, Nævi, Milium, Molluscum contagiosum, Epithelioma, Sarcoma, Lupus, etc., really belong to the group of skin diseases. It is sufficient here to mention their occurrence. They must be treated according to general principles.

Tonic and Clonic Spasms of the Orbicularis Palpebrarum Muscle are sometimes seen. The former is the result of some reflex irritation in which the lid is tightly closed. It is sometimes seen after a severe case

of Herpes ophthalmicus. The latter condition is manifest as a twitching of an eyelid, and occurs in people who are overworked, or who have some uncorrected error of refraction. It usually passes off after a time and is of no consequence.

Lagophthalmos, or inability to close the eyelid, is due usually to paralysis of the orbicularis muscle, and is one of the symptoms of paresis or palsy of the facial or seventh cranial nerve. It may also be caused by the pressure of an orbital tumour, by extreme exophthalmos, or any condition which renders the eye so prominent that the lid though active cannot be stretched over the globe.

Owing to exposure from this condition, ulceration of the cornea is frequently developed, especially if there happens at the same time to be a lesion of the trophic and sensory fibres of the fifth nerve. The cornea, however, in these cases is more protected than it might appear to be at first sight, owing to the fact that when an effort is made to close the lid the eye is rotated upwards through the associated action of the superior rectus muscle with the orbicularis.

Treatment.—In the paralytic cases the cause of the condition must be ascertained and treated, and in any case the eye must be protected from dust and from the drying action of the air. If there is anæsthesia as well, the eyelids should be pared in their middle third and stitched together, leaving the ends free and ununited. This is by far the most certain way of saving the cornea. Should the condition improve it is always possible to reopen the lids. In doing this simple operation great care must be exercised. If insufficient skin be removed from the lid margins they will not adhere, but if too much is removed it is very liable to cause the eyelashes to grow crooked, and they may turn in and produce the troublesome condition known as trichiasis. The eye must be carefully washed and kept very clean.

Symblepharon.—This is an adhesion of the lid to the eyeball, and is usually the result of injuries causing

destruction of the conjunctiva, such as burns from fire or chemicals. The adhesion may be of any width, from a thin strand to an adhesion occupying the entire extent of the eyelid. It is extremely disfiguring and very inconvenient, as it restricts the movements of the eyeball, and many reach so far forward that it overlaps the cornea. The worst cases are caused by pemphigus of the conjunctiva.

Treatment.—The deformity can only be overcome by means of a plastic operation, and its details must be entirely planned to suit the case under consideration. Most operations are accomplished by means of dissecting off the adhesion, and then cutting one or two conjunctival flaps to lie on the surface which was previously occupied by the symblepharon. In any of these operations on the conjunctiva only the finest silk sutures must be used, and after they are tied the ends must be cut quite short so that they cannot rub against the cornea.

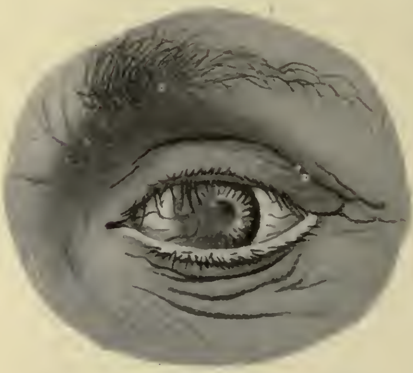


Fig. 21.—Trichiasis and distichiasis.

Trichiasis is a term used to indicate that condition in which the eyelashes grow in a wrong direction, and **Distichiasis** is that condition in which a second row of lashes is present, which also turn inwards, so that in both the cornea is rubbed by the lashes and a serious state of affairs is produced (Fig. 21).

Trichiasis and Distichiasis are caused by chronic inflammatory changes, such as trachoma and ciliary blepharitis, while many lid injuries will lead to it also. The second row of lashes are produced by offshoots from the hair follicles, due to long-continued irritation.

Treatment.—At one time it was the practice simply

to remove the eyelashes with their roots bodily, the so-called scalping operation, but this should never be done. The lid is not too large to cover the eyeball in health, and if it has become distorted and shrunken by disease it is already smaller than normal. If any portion of it is still further removed the condition becomes worse than ever. In addition the eyelashes are of the utmost use as a protection to the eyes, and they effectually catch many small flies and foreign bodies which would otherwise get inside the eye and cause much pain and irritation.

If only one or two lashes are turned in they may be got rid of, but the fewer lashes which are destroyed the better.

Epilation, or removal of the lashes, is performed simply by grasping the eyelash in a pair of forceps and pulling it out (Fig. 22). It gives temporary relief only, as the follicle remains and the lash grows after a week or two in exactly the same manner as before.

FIG. 22. Epilation Forceps.

Electrolysis.—This is perhaps the best way of destroying a few lashes. A fine needle attached to the negative probe of a battery is pushed into the follicle close alongside of the hair; the positive pole may be made of a wet sponge, or a metal electrode covered with wash-leather. When the circuit is made bubbles of gas are seen welling up by the side of the needle, and after half a minute or so the follicle is destroyed, if properly down the hair does not again grow. This operation is very far from being painless.

If a small bunch of ingrowing hairs are collected together in a cluster and are quite useless, they may be excised. If the whole length of the eyelid be involved, or the greater part of it, some form of plastic operation must be undertaken to remedy it.

The *Arlt-Jaesche Operation* is a very useful one. A Knapp's clamp is first applied (Fig. 23), and the margin of the lid is split along its entire length in such a manner that all the lashes are left in the anterior part. An elliptical piece of skin is then removed from the anterior surface of the lid. The clamp is removed, the edges of the two skin incisions are united with sutures, and a light dressing is applied. In this way the lashes are pulled outward and away from the eyeball.

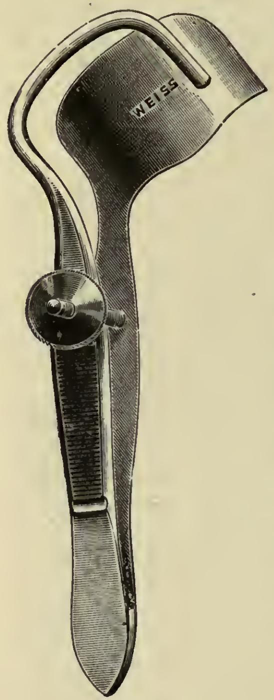


Fig. 23.

Van Millingen's Operation is done in much the same manner as the former, but the space which is left after splitting the lid is filled up with a piece of mucous membrane cut from the buccal surface of the lip. In some such way as this it is possible to put the lashes into very good position.

Entropion means the inturning of the eyelid, and as this carries the eyelashes against the surface of the eye, considerable pain and irritation, as well as damage to the cornea, are produced.

There are two main causes for entropion: one is the cicatricial contraction following such a disease as trachoma, and the other is the spasmodic rolling in of the lower lid which frequently takes place in old people, and is due to the relaxed condition of the skin of the eyelid. It may be readily produced in many people by bandaging the eye, and it is often troublesome after an operation such as that for cataract. It causes so much irritation that as a rule the bandage has to be left off, and perhaps other means adopted to prevent its recurrence.

Treatment.—Spasmodic entropion is frequently cured by simply leaving off the bandage and not tying the eye up. If it still persists or comes on independently of any bandaging the lid has to be fixed somehow. It frequently happens that if the lid can be prevented for only a few hours from rolling in it will not tend to recur, so that simple means may first be tried. One of the simplest is to take a piece of rubber strapping two inches or so long, with one end cut roughly to the shape of the lid, and attach it close to the lid margin. When it is adherent the other end is pulled on, and this tends to roll the lid out. When sufficient traction has been exercised it is fastened down to the cheek, and in this way the lid is held in position.

Another method is to paint the lower lid with celloidin or pure collodion (not flexile). As this dries and contracts so it shortens up the lower lid and holds it out. Another method is to enter a needle armed with a suture near the lid margin, pass it beneath half an inch or so of skin, and bring it out again; the two ends of the bight of thread are then tied together with a reef knot. Two or three of these sutures may be used.

A more permanent result is obtained by removing an elliptical piece of skin and muscle from beneath the lid margin; on stitching the two cut edges together the lid is drawn out. Care must be taken not to remove too large a piece of skin.

The entropion produced by cicatricial contraction is a much more difficult thing to treat. It may affect both eyelids, but the upper is perhaps more frequently involved than the lower; this is due to the greater ravages which trachoma makes on the upper lid. As a rule the tarsus is itself shortened and scarred, and this is where the chief difficulty lies.

Burow's Operation has the great advantage that no tissue is removed, so that however unsuccessful it may be, it never leaves the eye worse off than it found it. A shoe-

horn spatula is applied to the outer surface of the upper lid, and on this the lid is everted. The edge of it is grasped with a pair of broad fixation forceps. Both the spatula and the fixation forceps can be held in the surgeon's left hand. A horizontal cicatricial line is now visible near the lid margin. An incision is made in this line and extended along the whole length of the lid. The tarsus must be cut completely through, but care should be taken that the skin is not button-holed. As it is difficult to judge the depth of the cut, it may be completed with blunt-pointed scissors. When the incision has gone through as far as is necessary, a blue line is seen on the skin surface due to blood being just beneath it. It is as well to insert sutures at each end of the lid so as to keep the part containing the eyelashes away from the eye during the healing process. This operation always gives immediate relief, but recurrence is quite possible, though it often does good for a very long time. It is quite a simple operation and certainly a very effective one.

Another efficient operation is done as follows: A clamp having been applied to the lid, an incision is made through the skin parallel to the lid border and about two millimetres from it. A strip of the skin and muscle is removed and the tarsus is exposed. A wedge-shaped piece of tarsus is then removed, leaving its apex on the conjunctival surface. The skin may then be brought together with a few sutures.

Von Graefe's Operation consists of excising a triangular piece of skin from the lower lid with the base at the lid margin and the apex below. After loosening the edges they are brought together, and this tends to prevent the lid from turning in. Many other operations have been devised, but it is impossible to describe them here as they are far too numerous.

Ectropion.—This is the condition exactly the reverse of entropion, in which the lid is turned outwards. Like the former condition it may be either cicatricial or due to senile relaxation of the tissues of the eyelid. Intense

œdema of the lid and chemosis may also cause it. It produces great disfigurement, while the constant watering of the eyes is a source of much discomfort and excoriation of the skin. It is impossible for the lacrimal apparatus to act as the punctum is everted, and fluid cannot find its way into the lacrimal sac.

Scars on the face or lid from burns or other injuries are a fruitful cause of this condition.

Snellen's Sutures.—These sutures are very useful in the senile cases. They are inserted as follows: Two or three silk sutures about twelve inches long are taken, and on both ends of each, a fairly long half-curved or straight needle is threaded. One needle is entered into the most prominent part of the everted conjunctiva near one end of the lid, passed downwards and brought out on the cheek an inch or so below the lid margin. The other needle on the same thread is entered about three millimetres from the first, passed parallel to it and is brought out in the face about three millimetres from the point of exit of the first needle; in this way the bight of the suture includes about three millimetres of the conjunctiva. The second suture is passed in a similar way at about the middle of the lid, and the third (if three be used) is passed just like the other two near the other end of the lid. Now if the two ends of each suture be pulled upon, they will have the effect of drawing the everted conjunctiva down below the level of the eyelashes, and thus curing the condition. The two ends of each suture should be tied together over a piece of india-rubber drainage-tube or small roll of green protective. The sutures should be left in until signs of irritation are visible, when they may be cut out, and usually very great improvement results.

A very useful plan is the VY operation, which usually goes by the name of Wharton Jones, and is specially useful in cases of cicatricial ectropion. Suppose, for instance, a triangular-shaped scar causes the lid to be everted, a V-shaped incision is made with the base at the lid margin.

This flap is raised and dissected up. Sutures are now placed near the apex of the V, and the edges are drawn together for a certain distance, then the edges of the flap are made fast to the upper limbs of the V, and the result is a Y-shaped scar which considerably raises the edges of the lid (Fig. 24).

There are also many other operations which are suitable for certain cases, but each case has to be treated according to the exact condition present.

Ankyloblepharon, or the union of the lids together, is due to scarring from injury. It is fairly easy to separate

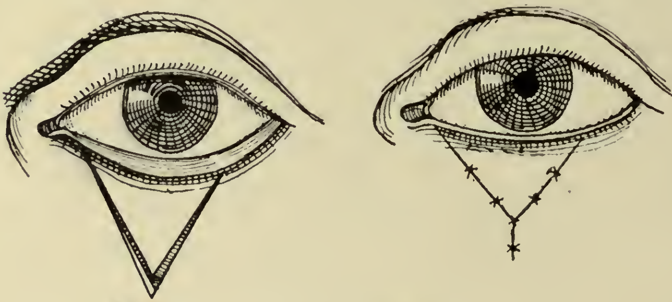


FIG. 24.—VY operation.

them, but unless some form of plastic operation is undertaken for the purpose, covering the cut margins with skin, union will take place and the condition will not be relieved.

Plastic operations of all sorts are required in order to restore damaged or destroyed lids. The condition may be due to burns or surgical operations such as is sometimes necessary in order to remove a rodent ulcer or other malignant growth. Lupus is often responsible for great destruction of the eyelid. For the relief of this condition large flaps, attached to a pedicle as broad as possible, have to be turned in from the neighbouring parts in order to fill up the vacant space, and these usually take well, but it is quite useless to cut large skin flaps from distant parts and transfer them bodily to the place requiring new tissue. As

a rule they unite at first, but they undergo gradual shrinkage and destruction, until after a time they disappear altogether, and it is impossible to see where they were originally placed; the contraction and cicatrization is as great as it was before the operation was undertaken. Thiersch grafts are far more successful.

Injuries of the Eyelids.—Owing to the loose tissue about the lids, a blow or injury is liable to lead to considerable extravasation of blood into the subcutaneous tissue, and the familiar black-eye is the result. Vertical cuts of the lid gape owing to the traction of the orbicularis, and ugly scars are the result. Horizontal cuts leave very much smaller scars, and are usually hidden in the folds of skin beneath or above the eyelids. Whenever an operation is undertaken on the lid, no vertical incision should be made if it can possibly be avoided, and the greatest care should be taken never to cut the lid margin, a conspicuous notch is the inevitable result.

Owing to a severe blow, or sometimes as the result of violent sneezing or straining, air may be driven into the subcutaneous tissue beneath the eyelids, and surgical emphysema is the result. The curious crepitation of air beneath the skin may easily be felt. The lids are generally much swollen, and the appearance is rather alarming, but it very soon subsides and complications seldom occur. If it is the result of a blow the probability is that there has been a fracture into the nose or one of the air sinuses communicating with it. These cases must be treated on ordinary surgical principles.

CHAPTER IV

DISEASES OF CONJUNCTIVA

The conjunctiva is a thin membrane covering the anterior portion of the sclerotic, and is represented by epithelium only where it covers the cornea. It goes back a certain distance, and is then reflected forwards on to the eyelids. The portion covering the globe is called the ocular conjunctiva. The fold where it is reflected is called the fornix, and the portion covering the lids is termed the palpebral conjunctiva. It is a delicate connective-tissue membrane in which are numerous nerves, blood-vessels and lymphatics, and also some mucous glands in the palpebral portion.

Hyperæmia of the Conjunctiva is a somewhat common condition, which may be considered as the first stage toward inflammation, though it may not reach so far. The vessels are somewhat injected and the membrane may be slightly chemosed, but beyond a tendency to lacrimation there is no abnormal discharge from the eye.

Causes.—Any slight irritation may produce this—a small foreign body, foul air, excessive smoking, the mere presence of tobacco or other smoke in the atmosphere, or any affection of the lacrimal apparatus, and the straining of the eyes with improper glasses or with no glasses at all when such are required.

Symptoms.—There is a general uneasy sensation about the eyes. Often a patient complains of a feeling as if a foreign body were present. After doing work for a short time the lids feel hot and heavy, and there is a great tendency for them to close. These symptoms are

always worse with feeble illumination and are especially bad when working by artificial light.

Treatment.—This is simple. The cause must be removed and the symptoms will quickly disappear with the aid of a simple lotion such as boracic acid gr. xv. ad ℥j.

Conjunctivitis.—Whenever the conjunctiva is really inflamed there is some hyper-secretion of the glands giving rise to a greater or less amount of discharge. In slight cases the palpebral conjunctiva only is affected; the surface is smooth, but the much-injected vessels are readily seen, and it is no uncommon thing to find hæmorrhages beneath it (sub-conjunctival ecchymoses).

If this goes on the ocular conjunctiva is affected in the same way. There is considerable lacrimation, and flakes of mucus are seen scattered about the conjunctiva more or less floating in the tears. The discharge is somewhat plastic, and when it dries on the face or edges of the lids it sticks to them and prevents the eyes from being opened after they have been closed in sleep.

There is a good deal of photophobia and superficial pain, which is very different from the deep-seated pain in the case of iritis; the lids burn and itch and feel as if the eyes were full of sand. Although a conjunctivitis of this nature does not really affect the sight, yet the secretion often adheres to the cornea and causes considerable disturbance of vision. A prismatic effect may be produced, which causes a light such as a candle or street lamp, to appear as if radiating coloured spokes emanated from it; these may be confounded with the coloured rings of light seen in glaucoma, but on careful inquiry one is able as a rule to distinguish between the radiating spokes and the definite rainbow appearance in glaucoma. As a rule there is not much photophobia unless the cornea is abraded or ulcerated.

Catarrhal Conditions are caused by several different organisms. A characteristic one is the *Angular Conjunctivitis,* so called because the inner and outer palpebral

angles are the most affected and are very red. The organism here is the *Morax-Axenfeld Diplobacillus.* It can easily be demonstrated by staining the discharge with methylene blue, and is decolorized by Gram's method. The disease is extremely contagious, but can be readily cured.

The *Koch-Weeks Bacillus* is the common organism found in mucopurulent conjunctivitis; it likewise stains faintly with methylene blue, and is Gram negative. It is also very contagious, and is frequently met with in children associated with phlyctenulæ. This condition causes intense photophobia.

Treatment.—All forms of mucopurulent conjunctivitis are favourably influenced by astringents. Zinc sulphate gr. j to iij ad ℥j acts practically as a specific for the Morax-Axenfeld variety, chloride of zinc of gr. j ad ℥j is equally good. A simple lotion like boracic gr. xv ad ℥j is as good as any to wash the eye with, and this should be used frequently and in large quantities so as to remove the discharge as soon as it is secreted. Lotio hydrarg. perchlor. 1/5000 is also quite good, but it is distinctly more painful to use than boracic, and for this reason is frequently but inefficiently applied. Painting with nitrate of silver 1% or protargol 10 % will materially assist the more severe forms of mucopurulent conjunctivitis. Care must always be taken not to use zinc or alum when there is any implication of the cornea, on account of their tendency to denude the corneal epithelium, and thus to favour the inroad of the organisms into the corneal tissue, which would quickly produce an ulcer. Cocaine, for the same reason, should be avoided.

Purulent Ophthalmia.—This is a far more serious condition than catarrhal conjunctivitis, and although the latter may become purulent, yet this severe variety is almost always, though not quite always, due to the gonococcus. It is chiefly seen in two main groups of cases: (1) ophthalmia neonatorum, which is due to infection taking place at the time of birth; (2) in persons of any

age in which the infection takes place from gonorrhœal discharge, it is seldom, however, seen except in adults, and usually the eyes are infected from gonorrhœa which the patient has.

(1) *Ophthalmia Neonatorum* is a well-known disease which is caused from vaginal discharge in the mother which contains the gonococcus at the time of birth.

For the first day or two nothing abnormal is seen in the child's eyes, but on the third day a discharge is noticed. The eyelids quickly become red and swollen, and there is a thick yellow discharge pouring from the eyes. Often the lids get stuck together, and on opening them purulent material comes out in large quantities. Unless efficient remedies are applied the cornea quickly becomes infiltrated, and an ulcer develops which in the course of a few days will perforate and entirely destroy the cornea. The iris becomes protruded, and often the lens escapes. After the disease has run its course the eye is represented only by a blind shrivelled mass. So serious is this disease, and so much destruction of sight does it produce, that it is responsible for about 30 % of all cases of blindness which are admitted to the blind schools of England. Yet in spite of this it is a disease which is easily checked and cured, provided only the case is seen early enough and before the cornea has become infiltrated. The treatment of it is so satisfactory that it may be taken as a working rule that if the cornea is clear at the time the surgeon first sees it, the eye should not only be saved, but all corneal complications should be avoided. Unfortunately there are some exceptions to this, for it sometimes happens, in very feeble children, that a cornea may slough and melt away in spite of the greatest care. Still the surgeon should hold it almost as an axiom that the eye will be saved if his treatment is efficient, and if his directions are fully and conscientiously carried out by the nurse or mother or whoever has charge of the infant.

The gonococcus can readily be demonstrated in the discharge by a smear preparation on a cover glass. It is a diplococcus, and frequently is seen within the leucocytes. The preparation may be stained with eosin and methylene blue. The other organisms which may cause purulent ophthalmia in infants are the staphylococcus, the Morax-Axenfeld bacillus, the pneumococcus, the bacillus coli communis and the Koch-Weeks bacillus. A true diphtheritic infection due to the Klebs-Löffler bacillus may produce a purulent ophthalmia, but there is less discharge than in the gonorrhœal cases, and there is a large development of membrane. This, perhaps, is the worst form of ophthalmia known. It is well to remember that all cases of ophthalmia neonatorum are not due to the gonococcus, and it is not so very uncommon to find serious injury to children's eyes in cases where it is practically certain that no sign of gonorrhœa has ever been present in either the father or mother. From the point of view of treatment the actual organism present is of little consequence, for with the exception of the diphtheritic cases the treatment is much the same for all cases.

The *examination* and *treatment* of the baby's eyes is of the greatest importance, and can only efficiently be done by any one who is used to examining eyes, or at least knows how to do it. The best way is for the surgeon and nurse, both wearing protecting goggles, to sit in chairs facing each other, and with a clean towel spread over the surgeon's knees. The baby is laid on his back with his head resting on the towel, while the nurse holds the arms and legs. In this way the child is under perfect control, and the surgeon has his two hands free with which to manipulate the eyelids. A basin of warm sterilized water or boracic lotion is alongside in which are plenty of small cotton-wool swabs. The lids are now open and pus pours out; this is wiped away with the swabs which are at once thrown away and destroyed. After the pus is removed the cornea will be

visible and its condition may be inspected. Owing to the child squeezing the eyes and to the swollen condition of the conjunctiva, the lids are so readily everted that the beginner will not find it easy to expose the cornea. This can, however, be managed if the surgeon keeps his finger tips on the margin of the lids, and draws them apart. It is never really necessary to employ lid retractors, and the fewer instruments used the better. If the cornea is clear the prognosis is good, if infiltrated or ulcerated it is decidedly bad. All the former cases ought to be cured without the eyes being damaged, while few of the latter will escape serious injury. The lids must now be thoroughly painted with nitrate of silver gr. x ad ℥j (2 %). In order to do this a smooth glass rod should be taken and a small quantity of cotton-wool wrapped round its end. This is dipped in the solution and carefully applied to the whole of the conjunctival surface, taking special care to get it well up into the fornices. After this nothing further is done until more discharge collects, when it is washed carefully away as before. It is not necessary or advisable to paint the lids with silver more than once a day. At all other times, and at least every half-hour, the lids must be washed with boracic lotion or lot. hydrarg. perchlor. 1/10000 by the attendant. The surgeon must take the utmost care in handling the eye to make sure that he does not scratch or otherwise damage the cornea. The whole safety of this structure depends upon the integrity of the corneal epithelium, and if this should be removed either by a scratch from the finger-nail, or a rough or broken glass rod, an ulcer is sure to form, and the cornea will either be lost or severely damaged. Some people use camel-hair brushes, but these should not be employed. They are never clean, and often have a sharp piece of quill which may scratch the cornea.

Strong chemicals are much to be deprecated. It is scarcely ever necessary to use more than a 2 % solution of nitrate of silver, and it is very doubtful if more than 3 %

or 4 % is even justifiable. These strong solutions only kill the corneal epithelium, while any stray organisms which have escaped readily find their way in to the damaged tissue. Probably more good is done by applying the silver once in twenty-four hours than more frequently, while many a case has been successfully treated with no strong application at all, provided constant and efficient irrigation is used to remove the discharge as soon as ever it collects. This is of the greatest importance. Yellow oxide of mercury ointment may be applied to the lids to prevent their adhering, and so helping to keep the discharge in.

Eserine has by some been supposed to have a beneficial effect on the cornea. This is doubtful, but the certainty of a blocked pupil should iritis develop is a sufficient reason for not using it in inflammatory cases. Atropine may be applied, but it probably makes very little difference whether it is used or not. Under treatment the discharge quickly subsides, and in two to three weeks it has disappeared. By this time the eye is either saved if taken in time, badly damaged if the cornea has been ulcerated, or totally lost if the cornea has sloughed. It cannot be too strongly impressed upon surgeons that the second and third conditions mentioned ought not to occur, and if they do it is almost invariably due to some one's fault or neglect.

(2) *Purulent Ophthalmia in the Adult* (*Gonorrhœal*).—This disease differs in some important respects from the same disease in infants, the chief of which is the extreme severity it assumes, for whereas in children it is almost always possible to save the eye if the case is seen before the cornea is implicated, in the adult a very large number of eyes are certain to be lost in spite of the greatest care and skill exercised in treatment.

There are a certain number of cases in which a purulent discharge is present due to organisms other than the gonococcus, and these can usually be treated successfully; but the true gonorrhœal cases, in which a profuse purulent

discharge is present, are altogether different. The cause is direct infection of gonorrhœal material from any source whatever.

The first symptoms are irritation and watering of the eye, which quickly becomes purulent, and in a day or two leads to the most profuse yellow discharge. The conjunctiva becomes chemosed, and is often so swollen as to protrude from the more or less closed lids. It is only with considerable difficulty that the lids can be separated, and when this is done the cornea may be seen at the bottom of a deep pit. At first it will be clear and covered with epithelium, but often this becomes shed and an ulcer forms. No sooner has the protective epithelial layer been removed than the interstitial substance of the cornea becomes exposed to the ravages of the disease. This quickly becomes infiltrated and necrosed, until in a short time the whole substance of the cornea is destroyed over a greater or less extent of its area, and Descemet's membrane only is left. When this happens the cornea, instead of looking opaque as it did before, becomes clear, and to the inexperienced eye it may look far less alarming than it did a short time before. It is, however, nothing but a danger sign, and this appearance is only due to the fact that the whole of the necrosed interstitial substance of the cornea has disappeared. Very soon Descemet's membrane will bulge and then perforate, and such an ulcer as this can only heal by the formation of a dense cicatricial opaque mass which will eventually take the place of the cornea, and which will almost certainly leave the iris attached to it; this will, according to its extent, cause partial or total blindness. If the perforation be large it is no uncommon thing to find the lens discharge itself through the opening, possibly the vitreous may follow, and the eye becomes totally lost. It runs exactly the same course as in the infant. Although as previously mentioned not every infant's eye will be saved, yet so successful is the treatment of a case which is seen before the cornea is infiltrated, that the

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surgeon should look upon one which is lost as being really due to some error of treatment; but in the adult almost half the affected eyes will be destroyed no matter how thoroughly the treatment be carried out.

The clinical appearance of the disease is sufficiently obvious to serve for the purpose of diagnosis, and should the patient himself be suffering from gonorrhœa it is almost certain that the ocular condition is due to auto-infection, but in all cases a microscopic examination of the discharge should be made in order to place the diagnosis on an absolutely certain basis.

Treatment.—Constant bathing is essential, and the most comforting thing is the application of an iced solution of boracic acid or hydrarg. perchlor. 1/10000. The lids should be everted or held away from the globe and painted once a day with nitrate of silver, 2 or even 3 %, while the bowels should be kept freely open with a mercurial purge; followed with copious doses of salines, such as sulphate of soda or magnesia. Owing to the severe course which this disease runs, a very guarded prognosis should be given in the early stages when the eye does not look particularly bad. A day or two later it is sure to look so bad that everybody will be alarmed for its safety, but if well treated a certain number will recover with little or no damage to the cornea. Antigonococcus serum has often been used, and the author has seen some apparent successes thereby, but generally the amount of good it does is not great.

Should one eye only be affected the greatest care must be taken to prevent the other from becoming involved, and this is almost certain to occur unless some sort of shield is put on to cover it. The best plan is to at once put on a Buller's shield (Fig. 25). This is made as follows: A piece of thin macintosh sheeting is taken about three inches square; in the centre of this a hole is cut a little smaller than an ordinary histological watch-glass; the glass is fixed into the hole with rubber solution or strapping and

with the convex side outward; the macintosh is securely fastened to the forehead and down the side of the nose. The patient is then enabled to look out of the glass, while any purulent material is prevented from getting into the eye. The outer part which is on the cheek is not stuck down, as it is essential to keep some

FIG. 25.—Buller's shield.

ventilation; if this be not done, not only will the glass become so steamed as to render it impossible for the patient to see out or the surgeon to see in, but it will produce a catarrh of the conjunctiva and a sore skin which may be mistaken for an early stage of the disease in the sound eye. After the eye is thus protected all one's energies may be devoted to treating the infected eye.

If a perforation has occurred the iris is almost certain to be involved in the scar; this causes a partial or

complete obliteration of the anterior chamber, and after the eye has healed it is very likely to become quite hard from secondary glaucoma. Should there be any clear cornea left it is as well to do an iridectomy as soon as ever the discharge has ceased and the redness has gone down. If, however, the cornea is replaced by scar tissue in which the whole of the iris is involved, it is impossible to do much. Sclerotomy may be tried with a view of lessening the tension, but in any case the eye is useless as an organ of sight. As soon as ever the tension becomes raised, the scar tissue begins to bulge, and very soon the eye becomes staphylomatous, painful, and is a considerable disfigurement. Under these conditions it had better be excised.

In the acute stage if the cornea has perforated and the iris has prolapsed no attempt should be made to excise it, as is done in a prolapsed iris as the result of a clean wound. With pus everywhere no good would result. If an iridectomy has to be done it is far better to wait until the eye has settled down.

Phlyctenular Conjunctivitis is the most common of all eye diseases in children. In its simplest form it consists of a small nodule with injected vessels running towards it. It is generally situated on the conjunctiva near the limbus, and usually more than one is present. After a time they ulcerate and break down and finally heal. They may spread on to the cornea and form ulcers, and are followed by vessels which insinuate themselves between the epithelium and Bowman's membrane. These ulcers may become infected with pyogenic organisms and lead to considerable destruction of the cornea. There is frequently a good deal of photophobia, and as usual the more superficial the lesion the worse is this symptom. Children often suffer intensely from it. Generally there is an eczematous condition about the nostrils and mouth, while cracks and fissures are certain to be found at the outer canthus. The number of phlyctens present varies

from one to many, and they not infrequently form a ring which extends round the cornea.

It is essentially a disease of childhood, and although not often seen in very young children, it usually comes on any time after the first year, and is seldom seen after about sixteen to eighteen years of age, though occasionally adults are affected. The children who suffer from it are generally of a strumous type, who are underfed, or badly fed; they have thick lips and swollen features, and although they do not always suffer from photophobia, yet very often this is a marked feature of the disease. They keep their eyes tightly closed and bury their faces in the bedclothes or their mother's dress, or anything whereby light may be excluded and pressure made upon the eyes. The lacrimation is intense, and on the slightest attempt to open the eyes, water pours out and violent sneezing takes place.

It is extremely difficult to obtain a view of the cornea, for even if the lids be forcibly separated the eyes are turned up so much that little or none of it is visible. In addition the cracked and fissured canthi must become very painful when the lids are forced open. Should the photophobia not be so severe a view of the cornea is easily obtained.

Treatment.—The first thing to do is to thoroughly examine the eye, and in order to obtain a good view an anæsthetic should be given in the worst cases. It is extremely unpleasant to struggle with a screaming child, and very dangerous to forcibly open the lids when the condition of the cornea is entirely unknown. It is quite possible the cornea may have a deep ulcer, and in the endeavour to obtain a view the ulcer may give way, and possibly the lens may be expelled. In any case under these conditions it is impossible to get a satisfactory view of the eye or to apply treatment as it should be done, whereas under an anæsthetic the child is quiet, the fissures can be forcibly stretched, which will greatly aid

their healing, and such drugs as nitrate of silver may be applied to the ulcer or the lids without causing pain. These cases are well worth treating thoroughly, and often after an anæsthetic and the vigorous application of remedies the photophobia disappears, while there is no risk of injuring the eye. While the child is under the anæsthetic every crack in the skin should be stretched and made to bleed, each scab should be removed, and nitrate of silver 1 or 2 % should be well rubbed into all sore places, while it is a very good thing to paint the everted lids and all ulcers on the conjunctiva and cornea with nitrate of silver 1 %. Atropine should then be put in. It is astonishing what an immense amount of good results as a rule from this treatment.

As regards internal treatment the first thing to do is to clear the bowels, and there is nothing like a good mercurial purge followed by salines. These children usually have some gastro-intestinal poisoning going on as the result of improper feeding, and they are always anæmic. One of the worst forms of treatment is to give iron, cod-liver oil, etc., in the first instance; it always makes the eyes worse and increases the symptoms, whereas mercury will do wonders. Later on iron, etc., is quite good but not before the whole system has been prepared for it. Half a grain or more of grey powder with about gr. $\frac{1}{4}$ of powdered belladonna leaves taken three times a day is excellent; locally, atropine drops or ointment 1 % should be applied, and when the eye is moderately quiet stimulating treatment, such as yellow oxide of mercury ointment, with or without atropine, according to the state of the eye is very useful.

Follicular Conjunctivitis is usually accompanied by some catarrh, but its chief characteristic is the development of follicles about the size of pins' heads in the lower cul-de-sac and adjacent palpebral conjunctiva. It seldom happens that the upper lid is much affected, and however bad it may be the lower lid is always the worst; in this

way it may usually be distinguished from trachoma, which affects the upper lid far more than the lower. These little bodies are really lymph follicles and never lead to scarring like trachoma does. Some authorities look upon this disease as being an early stage of trachoma, but this certainly cannot be proved, and most of the available evidence is altogether against such an idea.

Symptoms.—An eye suffering from this condition is usually uncomfortable and feels hot and irritable, especially on doing near work. There is usually but little injection, but the disease is difficult to cure and runs a chronic course.

Causes.—It is seen in its most highly developed form after the prolonged use of eserine or atropine. When it occurs in young people there is usually some local source of irritation, such as an uncorrected error of refraction. The patient may not be living under the best hygienic conditions, and the general health is perhaps not good. Remaining in vitiated or smoky atmospheres is very harmful.

Treatment.—The eye should be kept washed freely with boracic lotion, and drops of chloride or sulphate of zinc gr. j ad ℥j should be used two or three times a day. Some antiseptic ointment should be applied to the lids at night-time, such as ung. hydrarg. ox. flav. gr. iv ad ℥j. These remedies are on no account to be used if iritis is present. A dry climate with plenty of pure fresh air is most useful, and any general tonic treatment which may be indicated should be prescribed.

Trachoma is known also as granular conjunctivitis or granular ophthalmia. It is a serious disease not only to the patient who has it, but also on account of its great infectivity to those who come in contact with him. Its development and dissemination are always due to direct infection, and should the disease break out in a school, or anywhere else where a large number of people live together, it is sure to spread with rapidity unless the greatest care be exercised. The usual way in which infection takes place is by a

healthy person using a towel or handkerchief to his face which has previously been infected by the patient, while direct contact of an infected finger is certain to inoculate a healthy conjunctiva. Still, the disease is not so infectious as many others, and it seldom happens that nurses or doctors get it from their patients. The fact is, that with cleanliness and care a great deal may be done to check it. In families who are herded together in dirty insanitary dwellings the whole of them will probably suffer from the disease.

Symptoms.—After infection the eye soon becomes red and inflamed, and has much the same appearance as a case of catarrhal conjunctivitis; less commonly it assumes a very much more violent and acute aspect, and may resemble an ordinary case of purulent ophthalmia. When it appears in this severe form it is probable that there is a secondary infection as well. On everting the upper lid the conjunctiva covering the tarsus is seen to be reddened and inflamed, and a good deal rougher than normal. Very soon enlarged papillæ and follicles are noticed, and these give rise to a velvety appearance on the inner surface of the lids. Sometimes the papillæ are so large as to look almost like small growths. This stage of the disease is nothing like so frequently seen as the chronic form. With this there is some lacrimation and perhaps photophobia with little or no discharge. On everting the upper lid the disease is at once apparent. The surface of the palpebral conjunctiva and particularly the fornix is covered with follicles and is rough. The follicles vary much in size and appearance; sometimes they are like sago grains, but later on they are smaller and less numerous; but the appearance is quite characteristic. The conjunctiva shows much scarring, and this is particularly marked a few millimetres inside the edge of the lid, where there is often a cicatrix running its whole length, which by its contraction tends to turn the lid margin inwards. Scars are also seen in various positions on the tarsus. The fornix ought in all cases to be examined,

and this may be brought into view by making the patient look strongly downwards while pressing gently in the same direction with the finger above the lid.

The cornea soon becomes affected and leads to much impairment of vision. Sometimes this is the first symptom complained of. On examination a condition of pannus is seen (Fig. 26). This consists of vessels running in the subepithelial layers of the cornea. They are most marked in its upper half, but may extend all over it. It is very important not to mistake the case for one of interstitial keratitis. It may look very like it, but in reality the vessels in a case of pannus due to trachoma are much more superficial, but the depth of a vessel in the cornea is not always easy to determine. If the surgeon makes it a routine practice to evert the upper lid there can be no chance of falling into this error. Such a mistake is serious, as the treatment of the two diseases is very different. Often there is great pain in the eyes, and many of these patients are practically blind for a long time. While the eye is so inflamed there is a very real risk of corneal ulceration. Should this happen partial or total loss of the eye is no uncommon occurrence (Fig. 27). A deep ulcer always leads to a dense leucoma, and if it perforates the iris will probably adhere to the cornea, thus producing a leucoma adherens. Even if the trachoma is cured the vessels, though no longer carrying blood, will remain in the cornea and will thus render that structure less clear than would otherwise be the case. In the most

FIG. 26.—Pannus following trachoma.

severe cases the conjunctiva may be so damaged that a condition of xerosis or permanent dryness of it and the cornea may be produced.

Pathology.—Although everything points to the idea that trachoma is of microbic origin, yet up to the present no organism has satisfactorily been proved to be its cause, and we are still in doubt as to what it really is. Many

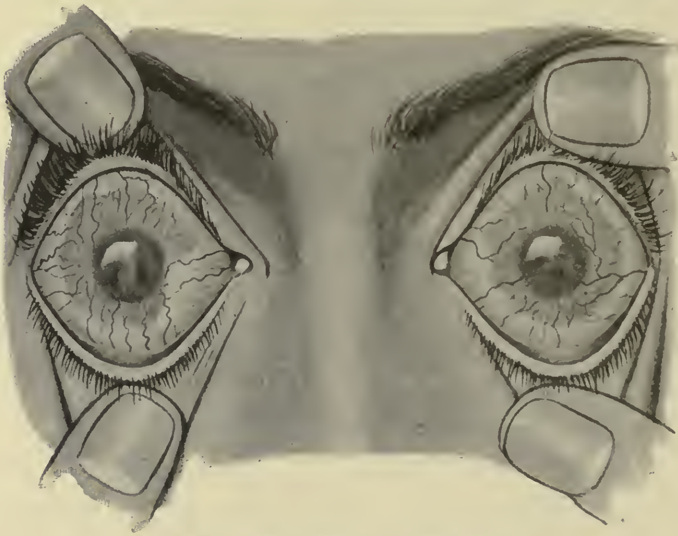


FIG. 27.—Later results of severe trachoma.

organisms are found in eyes affected with trachoma, but none peculiar to trachoma has as yet been identified. Histologically it consists of an enormous overgrowth of lymphatic tissue in the lids which after a time becomes degenerated, and scar tissue takes its place, leading to very great contraction which distorts and disfigures the eyelids. The cornea when in a state of pannus shows very great cellular infiltration in addition to the numerous vessels which are formed and which run in all directions. So great is this development of cells and vessels that the

so-called "salmon patch" is developed, and the cornea has the appearance of a red fleshy structure.

Diagnosis.—This is usually easy if the surgeon will only remember to evert the upper lid and examine its deep surface and the fornix. From follicular conjunctivitis it may be distinguished by the fact that the upper lid is chiefly affected in trachoma and the lower in follicular conjunctivitis, while the symptoms in the *latter* disease are far milder than in the former and do not lead to scarring. In some children the follicles in follicular conjunctivitis may be enormous, but the effect of treatment is soon obvious. Fortunately the treatment for both diseases is pretty much the same, but the more severe measures required in trachoma are not necessary for follicular conjunctivitis.

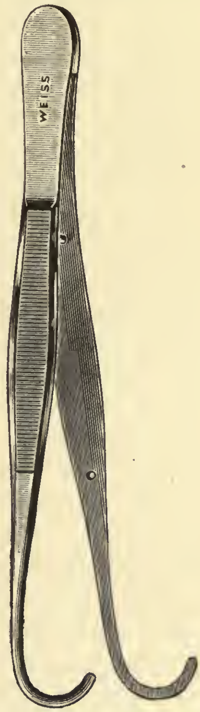


Fig. 28.
Graddy's forceps.

Treatment.—All sorts of things have been used in the treatment of trachoma, but they all fall into two main groups, operative and therapeutic.

Some authorities advocate the removal of portions of the conjunctival cul-de-sac, but considering the fact that the whole of the diseased tissue cannot possibly be removed, and also that conjunctiva once removed is never again reproduced, it cannot be other than dangerous to take away any portion of it. The great evil of trachoma is the destruction of conjunctiva and its substitution by scar tissue, therefore it is of very doubtful utility to remove any portion which may recover and prove useful later on. Expression is the method usually adopted, and perhaps the best forceps for this purpose are Graddy's (Fig. 28).

Two per cent. cocaine is first of all instilled into the eye,

then the lid is everted and solid cocaine is applied. The forceps are made to grasp the everted lid, the lower blade of which is passed well up into the fornix. The blades are then closed on the lid firmly, and are made to squeeze it as they are drawn away; in this way the follicles are crushed and a certain amount of jelly-like material is removed.

Knapp's roller forceps are sometimes used, but Graddy's are less painful, do their work better, and are far less liable to get out of order. After expression the conjunctiva may be painted with a solution of perchloride of mercury 1/500, or stronger still, even up to 1/25, but a good deal of pain is produced. As regards therapeutic measures which may be used with or without expression, the one which is most in favour is the rubbing of the surface with solid sulphate of copper or lapis divinus, which consists of equal parts of sulphate of copper, alum and nitrate of potassium fused together with a little camphor. It is best to have either of them pointed so as to be able to push them into the more prominent follicles. Nitrate of silver 2 % is useful to brush the lids with, or it may be used in the form of mitigated stick, which consists of a mixture of one part of nitrate of silver to two parts of nitrate of potassium fused together. It is never justifiable to rub the lids with solid nitrate of silver; it destroys the conjunctiva and is extremely painful, and considerably aids any contracting process which may be going on. Any silver salt has the disadvantage of causing staining of the conjunctiva (argyrosis) if it be continued, and this is most disfiguring. It is a very valuable remedy to use for a short time, but to go on with it continuously for weeks or months at a time is disastrous.

Jequirity has been much used in cases of severe pannus. It produces a membranous conjunctivitis, which when it clears up is found to have had a beneficial effect upon the cornea. The toxin from the drug has been isolated and is called "jequirol," which may be painted over the

lids two or three times at ten-minutes intervals. If the reaction is too severe it may be arrested and controlled by use of its antitoxin.

The exposure to X-rays and radium have been recommended, but have not found great favour.

One of the best of the more modern remedies is carbon dioxide snow. A pencil of the snow rammed into a hard mass in a mould is taken, and the pointed end is applied for several seconds to the everted lid. After it has thawed (and on no account before) the lid is returned to its normal position. Excellent results have been obtained by this method. The stick may be pointed by placing it against a metal vessel containing hot water. In any case the patient should be given a lotion with which to bathe the eye such as perchloride of mercury 1/5000, the strength of which may gradually be increased as he is able to stand it. Yellow oxide of mercury ointment should be applied to the lids at night-time.

The most important part of this treatment consists of arresting the spread of the disease, and for this purpose the patient should be isolated as far as possible. No one should sleep in the same room with him; all such things as towels, handkerchiefs, sponges, etc., must be most carefully kept apart from similar articles used by any one else. There is of course no fear of infecting any one without the direct inoculation of material from one eye to the other, so that the patient may go about as usual. Still in a child he should be carefully kept away from other children, for if not inoculation is certain to take place sooner or later, and the rapidity with which the disease spreads in schools, barracks, etc., makes it highly necessary to use every precaution to prevent its dissemination.

Diphtheritic Conjunctivitis is one of the most serious diseases to which the eye is subject, and before the days of antitoxin frequently led to destruction of the eye.

Symptoms.—These are somewhat similar to an acute

conjunctivitis, but more severe. The lids are very stiff, and the conjunctival surface is covered with membrane, which leaves a bleeding surface when it is removed. At first there is not a profuse discharge, but after about a week there is much elimination of material from the eye leading to extensive ulceration and cicatrization, and finally symblepharon or xerosis. The cornea is more often than not lost during the course of the disease.

Pathology.—The disease is due to the Klebs-Löffler bacillus, and is sometimes associated with diphtheria of the fauces or of the genitals in young girls.

Treatment.—Antitoxin has done more to eliminate the terrors of this disease than all other remedies put together. It acts here as well as it does on the throat. Locally quinine lotion made with the best quinine procurable is by far the most efficient application. It should be used in the strength of gr. iv ad ℥j; and should be dissolved with as small a quantity of dilute sulphuric acid as possible. About ♏j to each grain of quinine will just dissolve it. Caustic remedies like nitrate of silver should not be applied, as they still further tend to reduce the vitality of the conjunctiva and cornea.

Tubercular Conjunctivitis may be either primary or secondary. Primarily it may occur as the result of direct inoculation from an injury or secondary to lupus of the face and eyelid. The palpebral conjunctiva is usually the part first affected, and an ulcer of a very chronic nature develops which may last for years. Its rapid eradication is very necessary, as it may be the starting-point of general tuberculosis. The tubercle bacillus may usually be demonstrated.

Treatment.—Injections of tuberculin sometimes are very beneficial. The ulcer should be scraped and cauterized, and if small may even be excised. Should it be part of a patch of lupus the light treatment may be used if the necessary apparatus be available. The eye must be kept clean with some mild antiseptic lotion such as boracic.

If the eye be hopelessly involved excision had better be performed.

Pemphigus of the Conjunctiva is a rare disease, but a very fatal one as far as the sight is concerned. It may be associated with pemphigus of the body, but sometimes it appears in the eye alone.

Symptoms.—The attacks are attended with much pain and ulceration of the conjunctiva, which leads to excessive scarring and contraction of the membrane, until at last the conjunctival sac is completely obliterated and the margins of the lids may be turned in, while the lids themselves will be adherent to the eyeball. The cornea is by this time opaque and the sight is lost. The cause of the disease is unknown. grea

Treatment.—Nothing does anything towards arresting the disease. The distressing symptoms may be somewhat relieved by the application of emollients, etc.

Xerosis of the Conjunctiva in its severe form is the result either of pemphigus or very advanced trachoma, or other form of ulceration such as diphtheria. It usually leads to destruction of the eyeball. There is, however, a form of xerosis which is confined to the epithelium, and although the surface of the conjunctiva is dry in appearance yet it never leads to ulceration, and does the eye no permanent injury. These dry and greasy-looking patches are situated on each side of the cornea, and correspond fairly well to the palpebral aperture. The surface is often covered with small soapy-looking bubbles. One very curious fact about this disease is that the patients who have it almost invariably complain of night-blindness. They can see well enough in the daylight, but as soon as the light fails they can scarcely see at all. It almost always occurs in children who are badly fed and nourished; it spreads through schools, and the majority of cases are seen in the inmates of poor-law establishments. The prolonged exposure to strong sunlights in foreign countries is also said to be a predisposing cause, though the

disease is common enough in England where this cause is scarcely possible.

Treatment.—It is easily cured by general tonic treatment, good food and hygienic surroundings.

Pinguecula is a small yellowish mass of connective-tissue which occurs on the nasal, and sometimes on the temporal, side of the conjunctiva near the cornea. It is quite innocent and scarcely ever spreads. No treatment is as a rule adopted for it, but it may be removed if it is causing disfigurement.

Pterygium.—This is a vascular thickening of the conjunctiva which occurs on the nasal or temporal side of the cornea. It is triangular in shape with its apex directed towards the cornea. If allowed to grow it encroaches upon it, and even after removal it leaves an opaque mark which is disfiguring. It almost always occurs in persons who have been exposed to intense glare and much dust, consequently is not very often seen in England, but is common enough abroad in hot and dusty districts. It is occasionally seen in seamen from exposure to bad weather, but very rarely indeed in those who live a more or less indoor life. At first a number of dilated vessels are noticed running horizontally towards the corneal margin. The conjunctiva becomes thickened, and the whole resembles very closely a wing, as its name implies. If left alone it tends to increase in size and to spread across the cornea. Frequently they are double, one being on the nasal and one on the temporal side of the cornea.

Treatment.—If there is much irritation present this may be reduced by simple bathing, etc., but if the pterygium is large and fleshy nothing short of its complete removal will stop its growth. The best way is to cocainize the eye and grasp the growth near the cornea with toothed forceps. It is then separated from the adjacent conjunctiva with a knife or scissors and raised off the eyeball. A blunt strabismus hook is next inserted beneath it and its apex is torn away from the cornea. It is as well to excise the apex and close

the conjunctival wound with fine sutures. It should be remembered that, however well it may be removed, some thickening will remain for a considerable time, while the scar it produces on the cornea is never eradicated. Unless these facts be borne in mind disappointment may be experienced after the operation.

Subconjunctival Ecchymosis is a very common affection, which is easy to diagnose and is of no importance, though generally the appearance alarms the patient. It is due to the rupture of a blood-vessel, either as the result of an injury or it may come on spontaneously. It frequently occurs in children who violently strain themselves during whooping-cough, and in adults it may follow sneezing, coughing or vomiting. It may indicate a diseased condition of the vessels, especially if it occurs without any apparent cause.

An appearance similar to a subconjunctival ecchymosis is sometimes seen after a severe blow on the head, and is one of the symptoms of fracture of the base of the skull. Should there be an escape of cerebro-spinal fluid from the ear as well it is diagnostic of this condition.

Treatment.—Beyond keeping the eye clean nothing is required, the blood quickly becomes absorbed.

Nævus of the Conjunctiva is usually congenital and often pigmented. On account of the liability of these pigmented moles to become the starting-point of malignant growths, it is as well to excise them, for in any case they are disfiguring and useless.

Dermoids of the Conjunctiva are hard congenital growths usually situated at the cornea-scleral junction. They are smooth and covered with conjunctiva. In structure they resemble the skin, and frequently have small hairs growing on them which may cause some irritation. They may be dissected off, but it must be remembered that the cornea will not be clear underneath, and the result of the operation may be disappointing.

Dermo-Lipoma is a fibro-fatty growth usually situated at the upper and outer part of the globe. It is covered

with conjunctiva, and frequently long hairs grow from its surface, causing a good deal of irritation. In order to remove the tumour the conjunctiva should be dissected off and the growth excised. Whenever an operation is undertaken about the conjunctiva, the greatest care should be exercised not to remove any of it which can possibly be saved, as no eye has more than is necessary, and a shrunken conjunctival sac is a great disadvantage, while what has once been lost can never be replaced.

Papilloma of the Conjunctiva is a somewhat rare condition, and although it is innocent, yet it may become malignant, and it is always difficult to be sure when the change takes place. It is an undesirable thing to have from any point of view, and from its liability to become dangerous the sooner it is removed the better.

Malignant Tumours are not very common; they may be either carcinomata or sarcomata. They usually grow at the limbus, and are more often situated on the temporal side. The epithelial growths have the characteristic sodden appearance which overgrown epithelium has when constantly kept moist. They tend to spread locally and to recur after removal. The sarcomata are much more frequently pigmented, and although they may overlap the cornea yet they seldom adhere to it. They are generally flat and sessile, and are both locally and generally malignant.

Treatment.—It may be considered wise in an early stage to remove either of these growths, but time had better not be wasted in a useless endeavour to save the eye, for such delay generally ends in the life of the patient being sacrificed. It is far better practice to excise the eye and exenterate the orbit, as this gives the best, and practically the only hope of preventing metastatic growths which will eventually appear in the liver and other internal organs, in which situation they cannot be removed.

Lithiasis.—This consists of small collections of hardened secretion from the Meibomian glands. They may be seen

beneath the palpebral conjunctiva as small yellow nodules. After a time they work their way to the surface of the conjunctiva and push through it. They are then rough and sharp and cause considerable uneasiness of the eye and a feeling as if a foreign body were present. They are by some supposed to be associated with a gouty condition, though probably they have nothing whatever to do with it.

Treatment.—Under cocaine they may easily be removed with a needle or point of a narrow cataract knife.

Simple Cysts of the conjunctiva are fairly common, and usually consist of dilated lymphatics. They are small pearl-like growths and are of no particular importance. They may be incised and if necessary scraped out. Sometimes they attain a somewhat larger size.

Cysticercus Growths occur beneath the conjunctiva, which is freely movable over them. If incised hooklets can be seen and the whole cyst wall removed.

Injuriés of the Conjunctiva.—The conjunctiva is frequently injured by blows and cuts with foreign bodies, and also as the result of surgical operations.

Wounds of the conjunctiva very readily heal, especially if they are brought together with fine silk sutures.

CHAPTER V

DISEASES OF THE LACRIMAL APPARATUS

THE lacrimal apparatus consists of the lacrimal gland, the canaliculi with their two puncta, the lacrimal sac, and the nasal duct.

Each lid is provided with a punctum and canaliculus which lead into the lacrimal sac. Any affection of this apparatus causes epiphora, or watering of the eye, though the upper punctum and canaliculus but seldom give rise to trouble, and it is scarcely ever necessary to interfere with them.

The puncta are both situated at the apex of a small eminence near the inner canthus, and when in place they have a slight tendency to point inwards and so keep themselves applied to the surface of the globe; they are thus in the best position to induce the tears to flow towards the lacrimal sac. Should anything occur to alter their position, and particularly to make them look outwards, it will be impossible for drainage to take place properly, and epiphora will follow.

As the result of chronic inflammation the puncta may be so reduced in size as to be inefficient, or they may be closed altogether. Not infrequently a loose eyelash gets stuck into one or other punctum and causes great irritation. The canaliculus may be obstructed in the same manner as the punctum, but sometimes it happens that a growth of **Streptothrix Foersteri** may take place in it and cause much irritation and discharge without there being any affection of the sac itself, while the affected canaliculus can be felt to be hard and distended.

The cause of eversion of the punctum is usually conjunctivitis. The swollen conjunctiva pushes the lid away and the punctum is no longer in contact with the globe.

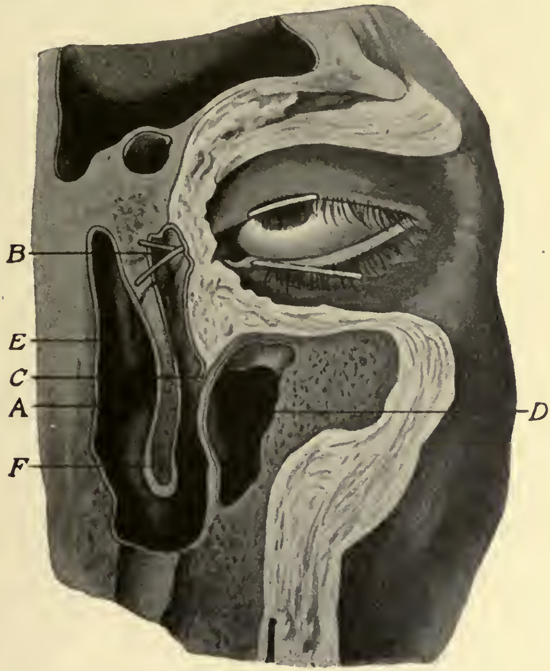


Fig. 29.—Section of the lacrimal apparatus. *A*, nasal mucous membrane; *B*, bristles inserted into the canaliculi leading into the lacrimal sac; *C*, outer wall of nasal duct; *D*, antrum of Highmore; *E*, middle turbinate bone; *F*, inferior turbinate bone. (After Symington).

Long-continued irritation will constrict and seal the punctum, while the growth of streptothrix is doubtless due to the introduction of the spores of the fungus from without.

Treatment.—The conjunctivitis which causes the eversion of the punctum must be treated with astringents such as zinc sulphate gr. j or ij ad ℥j, or painting the palpebral conjunctiva with nitrate of silver 1%. Sometimes it is useful to produce a small scar on the conjunctival surface with the galvano-cautery, so that by its contraction it

may turn the lid in just at the required spot. Should the lid be everted the case must be treated as one of ectropion (see p. 56).

If a growth of streptothrix be present it must be turned out. The easiest way to do this is to slit the canaliculus on the conjunctival surface, and never under any circumstances on the skin surface. But the fewer canaliculi that are slit the better. It is scarcely ever necessary to cut it, in its entire length, and even a growth of streptothrix can be quite well removed with a small probe and with much washing out. Still if a canaliculus be slit for a short distance very carefully, and if it be left alone for a couple of days afterwards, it will in all probability heal, but it is altogether unnecessary to slit a canaliculus with the idea of keeping it perpetually open, as it never acts efficiently as a drain after this is done. It may be dilated as much as is necessary, but only slit as a last resort. A loose eyelash in the punctum can be easily removed with forceps.

Lacrimal Sac and Nasal Duct.—By far the greater number of cases of epiphora are due to inflammation of the mucous membrane lining the lacrimal sac. This may become infected through the conjunctiva or through the nose. The mucous membrane then becomes swollen and causes a block in the nasal duct. Fluid can get into the sac, but the only outlet for it is by the way it entered. The mucus inside very soon becomes septic and purulent. This gradually finds its way back into the conjunctival sac and makes the eye water still more. It should be remembered that during health the conjunctiva and lacrimal gland only secrete enough fluid to keep the eyeball moist, in other words about enough to make up for the drying and evaporation from the surface of the warm eyeball. The result is that very little, if any, fluid finds its way down the nasal duct unless something such as a foreign body irritates the eye. Under these conditions, a copious flow of tears is at once produced, part of which flows through the lacrimal passages into the nose. If a mucocele or distended purulent

sac be present, the irritating material regurgitates slowly into the conjunctival sac, and causes a copious secretion of tears. If now the lacrimal passage were obliterated, and no septic material were present, little or no watering would take place until something irritated the eye again. This fact must be insisted upon in order to understand the rational treatment of lacrimal obstruction; the obstruction by itself is scarcely worth considering, while a septic lacrimal sac is a source of great discomfort to the patient and danger to the eye.

It not infrequently happens that a mucocele is present at birth or soon after, and sometimes it secretes so much material that the child may be thought to have purulent ophthalmia. Even a superficial examination ought to suffice to prevent this mistake being made, but it is by no means uncommon.

Nasal Duct.—This is frequently obstructed, and it is then impossible for fluid to pass down into the nose. The most common cause of obstruction is a mucocele or inflamed lacrimal sac. As the mucous membrane lining the duct is in direct connection with that of the sac, as well as that of the nose, it is not surprising to find that it participates in the diseases of both, but owing to its protected position it is usually quite healthy until it is involved in a secondary manner. There may be a fibrous or bony stricture in it, but this is either due to an accident such as fracture, to a tuberculous or syphilitic bone lesion, or as the result of the passage of probes. This latter is responsible for the greater number of strictures. It is often imagined that it is a stricture which causes the obstruction in the first place, as a rule it is nothing but an inflamed lacrimal sac, and no stricture will be present until probes are passed.

Treatment.—Congenital mucoceles are very easy to cure. Sometimes pressure with the finger over the sac will force the material down the nasal duct, which is blocked either by a fold of mucous membrane or by a plug of dried epithelium cells mixed with inspissated secretion. If this

proves insufficient an anæsthetic should be given, and the canaliculus dilated with a conical steel dilator (Fig. 30), so as to make it large enough to admit the nozzle of a lacrimal syringe (Fig. 31). The nozzle should be passed well into the sac and directed down the duct; fluid may then be found to pass into the nose. If it will not do so the syringe is withdrawn and a small probe is passed along the canaliculus, into the sac and down the duct; after this fluid is sure to pass. It is as well to roll the baby over on to its side before syringing fluid into the nose, otherwise it will get into the larynx and perhaps cause trouble to the anæsthetist. It is seldom necessary to do this a second time for nearly every case is cured at once. On no account should the canaliculus be slit.

FIG. 30. Canaliculus dilator.

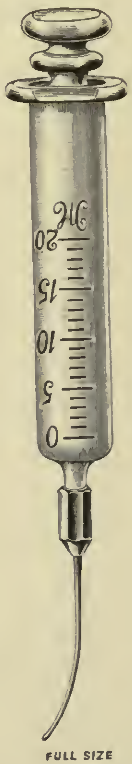


FIG. 31. Lacrimal syringe.

Adults are treated in much the same way, except that an anæsthetic is not required, and much syringing may be necessary in order to get the passage free. Here, again, the canaliculus should never be slit, neither should probes be passed frequently, a stricture is certain to form if this be done. Sterilized water or boracic lotion is the best thing to use for washing out a sac, but finally a few drops of protargol or sulphate of zinc are useful to leave behind. Never use enough of these drops to cause them to flow down the throat or larynx, and never force protargol in under pressure.

In passing a probe it should first be directed horizontally along the lower canaliculus until it can go no further and it is touching mucous membrane covering the lacrimal bone;

then the end is raised and the point directed downwards and slightly outwards in order to follow the direction of the duct. Force should not be used if it can possibly be avoided, for fear of making a false passage or wounding the mucous membrane. If the mucocele is not cured promptly by these means it is far better to remove the sac altogether, and thereby to permanently do away with the drainage apparatus. If this be done, so far from its causing the eye to water, it will prevent it from doing so; but if the patient weeps or if any irritation is present, the eye will water rather more than normally, but nothing like what it did before the sac was removed. The passing of large probes and the use of styles, though still recommended by

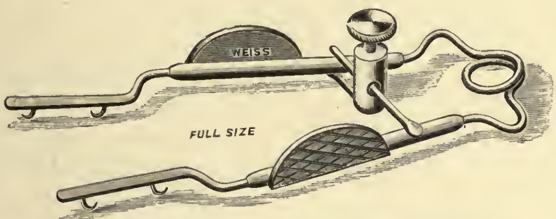


Fig. 32.—Retractor for lacrimal sac operations.

some surgeons, is in the opinion of most not good practice, and no description of them is necessary.

Operation for Excision of the Lacrimal Sac.—There are various ways of doing this, but one of the neatest and most efficient is that devised by Mr. T. Harrison Butler, of Coventry, who has kindly given me the details himself—

"The operation is best performed under local anæsthesia induced by novocaine with adrenaline. The needle of the syringe is introduced under the skin one centimetre above the internal palpebral ligament, and a few drops of the solution injected. It is now pushed further downwards, but still subcutaneously, and a few more drops are injected. Then the needle is partially withdrawn, and pushed down internal to the sac close to the bone, and a few more drops are injected. Finally the

needle is pushed into the lacrimal duct and a few more drops are expressed. If this be done carefully the operation should be painless and almost bloodless. About 10 to 15 minims are used. The angular vein is now defined, and the incision placed just external to it. This is roughly semicircular, and is described upon an imaginary diameter which is about 12 millimetres long, and passes through the inner canthus which represents the centre. This incision, which is superficial, marks out a flap which must be carefully reflected, and held back by a piece of silk which is held by the assistant. Great care must be taken not to produce a button-hole, for the outer aspect of the ligament is very superficial. The next stage is to define and isolate the ligament, by carefully cutting from within outwards with a small sharp knife. If the edge be turned towards the nose troublesome hæmorrhage may ensue. Now place a ligature under the ligament and let the assistant pull it downwards. A third ligature may be passed through the nasal lip of the wound to retract this if it seem necessary. Now expose the sac by making a vertical incision in the deep fascia, and when the sac appears separate its dome from the periosteum first with a knife and then with squint scissors. Seize the sac with forceps, and, keeping the points of the scissors close to the bone, separate it as low down as possible, and cut off the canaliculi. If the ligament be placed high up, pass the sac under it, and have the ligament pulled up. Then with the scissors separate the sac far down into the duct, and cut it off. Unite the wound by three horse-hair sutures and apply firm pressure. Remove the stitches on the

Fig. 33.—Blunt dissector and sharp spoon.

fourth day." Some surgeons find it convenient to keep the incision open while defining the sac with a speculum (Fig. 32), while a very convenient blunt dissector for raising the sac out of its bed is shown in Fig. 33.

After this operation the small incision very quickly heals by first intention, and in less than a week the patient is well and has for ever got rid of a bag of purulent material which is always at hand and ready to infect a wounded cornea or to produce a lacrimal abscess.

Acute Dacryo-Cystitis, or inflammation of the lacrimal sac, usually ends in a lacrimal abscess. It mostly develops as an acute affection following a mucocele, or as the result of bone disease; sometimes it occurs without any obvious cause.

The condition is very easy to diagnose. There is a large œdematous swelling in the region of the lacrimal sac, which is acutely tender and shows all the signs of suppuration. Sometimes a purulent discharge may be seen coming out of the canaliculi. If left alone the abscess gradually points on the surface and will eventually discharge itself, leaving as a rule a very troublesome fistula. Because of the extremely septic nature of the disease a spreading phlegmonous condition may extend to the surrounding tissues for a considerable extent.

Treatment.—In the early stages hot bathing and fomentation may cause subsidence of the trouble. If not an abscess will form and will have to be opened. This should always be done by an incision through the skin over the most prominent part of the swelling. Some surgeons endeavour to evacuate it through slitting the canaliculus in order to avoid a wound on the face; but as the skin wound will heal practically without a visible scar, and the canaliculus never will if kept open long enough to drain, it is far better to make the opening at the place where the abscess is pointing. After a few days of fomentations things will quiet and no further trouble may be experienced; if, however, there was a mucocele to start with, this will not be cured, and the sac had better be excised as soon as possible.

Inflammation of the Lacrimal Gland, or Dacryo-Adenitis.—An acute abscess of the lacrimal gland is by no means uncommon; it is probably the most frequent cause of orbital suppuration, but it is not always recognized, and so it happens that it is looked upon by many as a rare disease. The gland sometimes gets into a state of chronic inflammation which does not necessarily go on to suppuration. It gives rise to redness and swelling of the upper lid and displacement of the eyeball. It usually follows certain general infections, viz.: syphilis, gonorrhœa, tubercle, mumps, measles, scarlet fever, rheumatism and some cases of general septicæmia. It is important to remember that it may occur as a sequel of gonorrhœa long after the primary disease, just as iritis and rheumatism may do. In most instances, the inflammation subsides with general treatment, but suppuration may occur.

Treatment.—In the acute stage, when an orbital abscess forms it must be opened and fomentations be applied. It usually points at the upper conjunctival fornix, and may be opened here, but it is not a very satisfactory place either for the well-being of the eye or for drainage purposes, so that as a rule it is better to open the abscess through the skin of the upper lid. The disease which causes it should be treated if possible, and fomentations applied locally. Should the gland be tubercular it had better be removed altogether. This may be done without the least fear of producing xerosis or dryness of the conjunctiva; the glands of the conjunctiva are far more important for the purpose of lubricating the cornea than the lacrimal gland.

Tumours of the Lacrimal Gland.—The following growths have been seen: sarcoma, carcinoma, cylindroma, adenoma, lymphoma, and lymphosarcoma (often bilateral and symmetrical), tubercular growths and cysts. They are rare, and are discussed under the head of Tumours of the Orbit on p. 225.

CHAPTER VI

DISEASES OF THE CORNEA

THE cornea is that part of the eye which covers the iris, and in health is quite transparent. It is the most important of the refractive media in the eye, and without it no vision, more than light perception, is possible. Its surface is covered with stratified epithelium which is derive from the epiblast, and which really is the modified conjunctiva.

Beneath this is the thin but rather tough Bowman's membrane, covering the interstitial substance of the cornea which is derived from the mesoblast, and underneath that is Descemet's membrane, which is covered with a layer of epithelium and forms the boundary of the anterior chamber.

Diseases which affect the conjunctiva are liable to involve the superficial corneal epithelium, while diseases which attack mesoblastic structure generally, such as syphilis, frequently affect the interstitial substance of the cornea, the ciliary body, the iris and the choroid. It is thus sometimes difficult to know exactly how to describe a case, for there may be general affection of all these structures.

Injuries of the Cornea.—From its necessarily exposed position the cornea is more liable to injury than any other part of the eye. It must always be exposed during the time sight is required, except for the minute period of time while the lids sweep its surface in the act of winking. Fragments of dust floating in the air are constantly falling upon it, but it is so sensitive that directly this

happens, and the surface of the cornea commences to get dry, the lids are swept over it, thus cleaning and moistening it again. If now a fragment of dust above a microscopic size gets into the conjunctival sac it may get under the lids or adhere to the surface of the cornea and cause much irritation.

Abrasions of the Cornea.—Owing to the extremely sensitive nature of the surface of the cornea an abrasion is one of the most painful things which can happen to an eye.

A scratch from any object may cause the surface epithelium to become abraded, and when this happens nerve endings become exposed, and irritated. Usually an abrasion is readily seen by means of the oblique method of examination, and if this does not reveal the scratch, a drop of fluorescine placed in the conjunctiva will stain it a vivid green. The eye is injected, there is profuse lacrimation and frequently photophobia.

Provided no septic material gets into the eye, the abrasion quickly heals and the pain ceases; but should there be a mucocele or other septic condition about the conjunctiva the whole eye may be lost.

Treatment.—Atropine relieves the pain quicker than anything except perhaps cocaine, but the latter should not be used, as it causes insensibility of the cornea, drying and disintegration of the epithelium, and does far more harm than good. Atropine relieves the congestion, dilates the pupil (which is usually very small when the eye is injected), and greatly diminishes pain. The eye should be tied up for a day or two in order to keep the lids quiet and the cornea free from irritation.

Foreign Bodies in the Conjunctival Sac.—These may be under either the upper or the lower lid, but as a rule the latter are so easily removed by the patient that the surgeon is not often called upon to do this. The whole of the lower cul-de-sac is completely exposed if the patient looks upwards while the lower lid is drawn downwards with the finger. These frequently injure the cornea.

The upper cul-de-sac is not nearly so readily seen. Still it is quite easy to examine it if the patient will look down to the ground the whole time. The eyelashes are then held between the finger and thumb of the surgeon who everts the upper lid. It is generally easier for a beginner to roll it over a probe or glass rod which is held horizontally at the upper margin of the tarsus. This method, though difficult to explain, is very easy to do if one sets to work the right way. The secret of it is that the patient must look down and not squeeze. The foreign body will then be seen adhering to the inner side of the upper lid which is turned out. Nearly all these foreign bodies can be removed by the patient himself if he will look down, take hold of his upper eyelashes, pull the lid forwards and downwards over the lower lid margin and then let go. It will be found that the lower lashes have swept the foreign body out of the conjunctival sac.

Foreign Bodies in the Cornea are difficult to remove skilfully, and if they are not carefully extracted they cause considerable pain and discomfort to the patient, and far more than need be the case. The severity of an injury to the cornea largely depends upon its depth; thus if a small foreign body such as a grain of sand blows in and strikes the cornea it will probably get embedded in the epithelium only, whereas if it flies off a piece of steel, say, from a hammer or a grindstone, it will be travelling with far greater velocity, and will embed itself deeply into the interstitial substance of the cornea. Sometimes it may go so deep that one end may be actually projecting in the anterior chamber, while if it was travelling with still greater velocity it may have got free in the anterior chamber. If a patient comes complaining of something in the eye the cornea must be searched with the greatest diligence. It is marvellous what a number of foreign bodies are missed by those who are not accustomed to look for small objects. The oblique illumination must always be used, and very often the corneal loupe as well. Some foreign bodies are of

extreme minuteness. They can sometimes be rendered visible by using a dim light and the plain mirror of an ophthalmoscope with a high convex lens behind it.

Treatment.—The foreign body must be removed as quickly as possible. For this purpose cocaine should always be used so as to anæsthetize the cornea. If the foreign body has simply blown into the eye the least touch will dislodge it, but should it be deeper it will be more troublesome to get away.

The removal of a foreign body from a cornea is by no means so simple a thing as it looks, and the greatest care has to be taken to do it neatly. As has been before remarked, the pain of an abrasion, which is usually severe, is in proportion to the area involved. Consequently if the surgeon scrapes and denudes a large area of the cornea, the patient will suffer far more pain than if he only injured the epithelium immediately adjoining the foreign body.

The patient should be seated in a chair or lying on his back facing a good light, either daylight or artificial, but it is always easier to see a foreign body by artificial light, such as an electric hand lamp. An assistant then takes a convex lens and focuses the rays of light on to the cornea. A fine spud or a cataract needle is taken in the right hand and held firmly, while the hand itself is resting on the patient's forehead, the fore and middle fingers of the left hand are used to open the eyelids. Then with the most careful movements the spud is delicately inserted beneath the foreign body, when it is gradually eased out of its bed.

When the operation is completed, only the epithelium immediately in contact with the foreign body should have been disturbed. If an area five or six times the size of the foreign body be scraped up and rendered rough it is a sure sign of want of skill on the part of the operator. When a piece of steel or iron has found its way into the cornea it is frequently difficult to get away the last trace of brown colour, and often enough it is considered to be a stain only and is then left. The fact remains, however,

that the so-called stain can usually be removed if sufficient trouble be taken, and it invariably is found to be a perceptible piece of the foreign body. Pieces of iron, and particularly emery, are very troublesome to remove owing to the way in which they break up. If the foreign body be a needle-shaped piece of steel which has deeply entered the cornea end on, it may be extremely difficult to remove it, for it is impossible to see whether it is actually projecting into the anterior chamber. If it is as deep as this it may be very dangerous to attempt to remove it with a spud, in case it should be pushed through altogether. Should this happen the foreign body must be got out, and the only way will be to make an incision and withdraw it with a magnet, but this is nothing like so easy to do as it might appear to be. There would be no difficulty about it if the anterior chamber remained full, but when the incision is made the aqueous escapes and the iris and cornea come into contact. The foreign body then gets entangled or lost in the iris. If it be so deeply embedded in the cornea that there is a risk of its getting lost, it is far better to give up all attempts to remove it in the ordinary way and to trust to the electro-magnet, which will very likely draw it out. The foreign body may be immediately followed by the aqueous, thereby showing that there was a hole through the cornea, which was plugged by the foreign body much like a thorn will plug a puncture in a bicycle tyre.

After a foreign body has been removed, and especially if there is a large abrasion, atropine should be put in and the eye tied up for a few days. Unless any septic infection takes place, the abrasion heals quickly and little or no visible scar remains.

Recurrent Abrasion of the Cornea is a rather rare condition and a particularly troublesome one. It is usually started by a scratch, as often as not done by the finger-nail of a baby as the nurse is holding him. This runs the usual course of an abrasion and heals, then after an interval of days or weeks the eye suddenly becomes painful, and on

examination the epithelium is seen to be denuded much like it was by the original injury; this heals only to break down again, and so the process is repeated.

The cause of the trouble appears to be that after the abrasion the epithelium does not adhere so firmly as it should do; and then a little fluid gets beneath it and raises it up, forming a small bulla, which very soon breaks down and leaves the nerve terminations exposed. This causes severe irritation and pain until they get covered again.

Treatment.—The majority of cases eventually get well. If they continue troublesome the best thing to do is to pull off all the loose epithelium, or to scrape the abrasion with a spud and let it heal up from the bottom. Although cocaine will ease the pain it should not be employed, as it tends to disintegrate the corneal epithelium and to make things worse. Atropine gives more relief than anything. Boracic lotion should be used to bathe the eye with, and where an abrasion is present the eye should be tied up. A simple ointment such as boracic made with lanoline and vaseline is useful and soothing.

Blood-staining of the Cornea.—It sometimes happens after a severe blow that blood gets extravasated into the corneal layers and produces a distinct greenish discoloration due to hæmatoidin. In these cases blood is always present in the anterior chamber, and it is probably from here that absorption into the cornea takes place. It takes a very long time to absorb.

Chemical Burns of the Cornea.—These injuries may be caused by acids or alkalies, and are always serious. If sufficient lime or other caustic alkali enters the eye so as to seriously damage the cornea, the chances are that the conjunctiva will be so burnt that a symblepharon will be produced which will demand subsequent treatment. The worst of such burns, and especially the alkali ones, is the great penetrating power possessed by these chemicals even more so than by acids, and this is due to chemical

combination with the tissues. Molten metal, hot water, steam or fire frequently injure the cornea.

In considering the severity of this class of injury and the chance of recovery, it should always be remembered that a burn, especially one due to chemicals, never looks so bad at first as it will do subsequently. The tissue will be more or less destroyed, and usually leave a clean raw surface behind. The whole of the corneal epithelium may have disappeared and the deeper layers may be damaged, but at first they will look fairly clear and no contraction will have taken place. It is, therefore, injudicious to say that any chemical burn of the eyeball is a slight one until several days have elapsed and it is possible to see what is happening. A cornea which appears clear at first may become opaque, and a burnt conjunctiva which looks only slightly injured may lead to serious cicatricial contraction when it heals. It is wiser to take a serious view of all burns until such time has elapsed to prove that they really are slight.

Treatment.—As a rule it is but very little use to try and neutralize an acid or alkali in the eye. The damage has all been done long before the surgeon is likely to see the patient, and in any case only the smallest possible amount of a chemical can be really present in the eye, even a second or two after the accident, unless, of course, it happens to be solid material, such as lime, mortar, etc. The best thing to do is at once to wash the eye out thoroughly with water, and not waste time trying to get anything else. If lime has caused the trouble the eyelids must be opened and everted, and every particle of foreign material should be carefully removed. It is astonishing what a lot will sometimes find its way into the conjunctival cul-de-sac. Any particles on the cornea must be removed with the greatest care. If the burn is at all extensive the cornea will eventually become so opaque that all useful vision will be lost. In the most severe cases the cornea may itself be perforated and then nothing is likely to save the eye.

Non-penetrating Injuries of the Cornea usually heal without trouble, unless infected.

Penetrating Wounds of the Cornea are always serious, and they are perfectly easily seen; yet it is astonishing what a number are brought only after an interval of days, because the eye did not seem to be getting better. Even medical men sometimes fail to appreciate the fact that the eye has been wounded. The amount of actual damage depends entirely upon the extent and the nature of the injury. A small penetrating wound done, say, with a needle may lead to the loss of aqueous only, and perhaps scarcely to that; but probably the lens will have been injured and a traumatic cataract will be the result. One of the commonest accidents in children arises from the child endeavouring to untie a boot-lace with a fork; if this slips and strikes the eye, usually two prongs at least penetrate the globe, and as the fork is sure to be septic suppuration of the globe usually follows. A pointed pair of scissors is responsible for many a damaged eye. If the wound be anything more than the smallest needle-prick the aqueous will escape and carry the iris with it, and this will block the wound and remain caught between the lips. The pigment on the prolapsed iris soon becomes shed, and it may scarcely look like iris at all.

Treatment.—The only thing to be done with regard to the treatment of corneal wounds is to see that the lips are in apposition, and that nothing in the way of iris or lens capsule is between them, while the greatest care should be taken to try and prevent anything such as iris or lens capsule from adhering to the deep surface of the wound, but this is not always possible. Atropine must be used in all cases of injury to the eye, and a light pad and bandage should be applied. (For the treatment of prolapsed iris see p. 138.)

Scars on the Cornea are termed *nebulæ*, *maculæ*, or *leucomata*, and they all mean much the same thing. A nebula is a faint scar or cloudiness; a macula is a definite

opacity; while the term leucoma indicates a large white scar such as that following a severe ulcer. If the ulcer has perforated, the iris may become adherent to the scar, and this is termed a *leucoma adherens*.

Even the faintest nebula will cause considerable obscuration of vision, not so much because of its density in obstructing the light, as on account of the irregular astigmatism which it produces.

One of the densest forms of scars are those due to a deposit of lead in the cornea. It is well known—unfortunately far too well known—that acetate of lead lotion is an astringent, and that it does good to certain eye conditions, notably in cases of conjunctivitis; and here it does as much good as any other astringent and no more. It is, therefore, used by some people for any red eye. If, now, there happens to be a corneal ulcer, the lead goes down as a white mass and accurately fills up any abraded surface with a deposit as white as porcelain, and there it remains permanently, and if the ulcer happens to correspond to the centre of the pupil, this dense white mass will completely obscure the sight, and in any case will cause serious disfigurement. The only way to get rid of it is to scrape it away just like a foreign body, but if the opaque area is large very severe damage may be done to the cornea, while it is most difficult to get rid of every trace of whiteness. Inasmuch as there is no condition in which lead is superior as a lotion to zinc or any ordinary astringent, it should entirely disappear from the list of drugs which may be used to the eye. It is far too dangerous to be put in the hands of any patient for fear it may be used on an eye with an abraded cornea.

Treatment.—Corneal nebulæ are the result of inflammatory changes or scars, and consequently they cannot be removed. When a nebula first forms as the result of an ulcer, it is always much denser than it will be months or years afterwards, owing to the fact that there is a good deal of inflammatory exudation present which will become

absorbed in time. In order to assist this, such things as yellow oxide of mercury ointment are used, combined with massage, or dionine drops from 1 to 5% The way in which these things act is by hastening the circulation and assisting the absorption of the products of inflammation. It is quite useless to expect that a scar in the cornea will disappear more completely than a scar anywhere else in the body.

Dense white scars which occur in blind eyes, or in such a peripheral position on the cornea that they are away from the pupil, may be hidden *by tattooing them with Indian ink.*

The best Indian ink is rubbed up into a paste on a piece of glass, and then some of it is placed on the leucoma. Numerous pricks are made with a discision needle in order to allow the ink to penetrate some little distance into the substance of the cornea. The ink may then be washed off and the result noted. It takes a long time to get a nebula covered in a satisfactory manner, and often two or three sittings are required. It is not a wise thing to tattoo a leucoma adherens, as a severe cyclitis may be set up; it is far better to divide the adhesion first and then tattoo subsequently. The eye being under the influence of cocaine, the operation is painless. The eye must *never* be fixed with ordinary fixation forceps while Indian ink is being used, for if it is, the most conspicuous black mark will be left in the conjunctiva, which will show up prominently on the white sclera. It is altogether unnecessary to use even a speculum. The fingers of the left hand can be employed to open the eye and to steady it, and no other instrument than the needle should be used during the entire operation, for fear of making an abrasion which will take up the pigment.

Phlyctenular Keratitis is described under Phlyctenular Conjunctivitis, as it is essentially a conjunctival disease.

Dendritic Ulcer.—This is by no means an uncommon

form of keratitis, and it is very important to recognize it when it occurs. The disease generally comes on without any known cause. The eye becomes irritable and painful, and the sight may be more or less affected. On a superficial examination but little may be seen, but if carefully looked at a small abraded surface is apparent. If a drop of fluorescine is put into the eye a curious ulcer is seen stained a bright green, with radiating arms extending in various directions over the cornea. It will be seen to be spreading in one direction, and healing in another, and in the course of a few days may shift its position considerably. Wherever it has been, a faint nebula is left, and wherever it is spreading its processes will be stained with the fluorescine. It is quite superficial. Unless the condition is recognized and treated energetically it will continue to wander over the cornea, and will leave very definite marks behind. If inefficient treatment only be used, it will not heal, and there is always a danger of the ulcer getting infected with pyogenic germs, when a deep spreading hypopyon ulcer will develop, which may destroy the sight. From its appearance and mode of spread it has been supposed to be due to a fungus, but this has never been proved, and in fact no organism has been found to be always associated with it.

Fig. 34.—A superficial ulceration of the dendritic type.

Treatment.—The surface of the ulcer must be cauterized

in some way or other, and it makes very little difference how this is done. The eye should be cocainized, and then a drop of fluorescine put in, in order to see the exact extent of the ulcer. A spud or very small gouge is then taken and the whole of the ulcer is scraped. After this, the scraped area is dried with a pointed end of a piece of blotting-paper and some caustic fluid applied. Pure carbolic acid is as good as any. The most convenient way of using it is to take a small piece of wood like a match and carefully point it. It is then dipped in the acid, and being porous it absorbs a certain amount which will gradually diffuse on to the surface of the ulcer and turn it quite white. Some people dip the spud in the carbolic and use that, but the disadvantage of that is, that a large drop will adhere to the polished surface or else none at all. If the large drop runs off it may spread far beyond the limits of the ulcer, which makes a large abraded surface; this never happens if a piece of wood be used. The surface is again touched with blotting-paper to dry up any excess of acid, and finally some atropine and cocaine ointment, 1%, is put into the eye and rubbed over the surface of the ulcer. The eye is tied up, and if it should be painful later hot bathing will relieve it. If these directions be carried out there is astonishingly little pain. Nitrate of silver gr. x ad ℥j, perchloride of mercury, 1/500 or stronger, absolute alcohol, the actual cautery, etc., may all be used, but the carbolic, which is in itself a local anæsthetic, is the least painful and acts quite as well as any other. The process at once stops, the ulcer heals, and it is very seldom necessary to touch it a second time.

Fig. 35.
Spud.

Fig. 36.
Gouge.

Filamentary Keratitis is a curious condition, in

which the corneal epithelium becomes detached and laid up so as to form small filaments, which are attached to the cornea at one end and free at the other. They are the exact counterpart, microscopically, of small laid-up pieces of rope. The disease starts as a vesicular keratitis, the vesicles burst, and the loose epithelium gets worked up by the action of the lids into these curious rope-like filaments. In a well-developed case they can be picked up with a fine pair of forceps, cut off and examined microscopically, when they exhibit a very interesting appearance. They stain well with fluorescine, and so do the small depressions from which they hang.

The cause of the condition is not very obvious, but it probably is connected with defective nutrition of the cornea. The condition itself is rare, but when seen it is generally in elderly and debilitated people, and it sometimes occurs after an operation, such as cataract extraction.

Treatment.—It usually cures itself after a short time. Chloride of ammonium 2 % used as eye-drops, four or five times a day, or sulphate of zinc gr. j ad ℥j soon causes the epithelium to exfoliate. The eye should be protected by a pad and bandage.

Bullous Keratitis.—This seldom occurs except in diseased eyes, such as those blind from glaucoma or irido-cyclitis. Very rarely it may be a primary condition. Large bullæ develop on the cornea, causing considerable pain, and then eventually burst and the epithelium gets shed. The best treatment is to cut away all loose epithelium with scissors, while locally hot fomentation and atropine may be used unless otherwise contraindicated. Should the eye be painful as well as blind it is far better to excise it.

Vesicular Keratitis is really a modified form of bullous keratitis, but the vesicles are much smaller and are often the starting-point of filamentary keratitis. The etiology and treatment are much the same as those of bullous keratitis. It very seldom occurs except in degenerated eyes.

Mooren's Ulcer.—This variety of ulcer, from its persistent and progressive nature, is sometimes called **Rodent Ulcer of the Cornea**; but it has nothing whatever to do with rodent ulcer of the skin and is a totally different disease. It commences near the limbus of the cornea, and spreads round the edge and over its surface. It does not destroy the whole thickness of the cornea, nor does it cause perforation; but it destroys the cornea quite deep enough to render it almost entirely opaque. It has very overlapping edges, and heals and cicatrizes at one place while it spreads at another. It is extremely difficult to cure. Very thorough cauterization with the galvano-cautery is the only thing which seems to have any effect upon it, and this sometimes stops it. After it is arrested the cornea may clear a good deal, but the sight is seriously affected. It sometimes attacks both eyes, and frequently leads to blindness. It is fortunately a rare disease, and its progress is slow though sure.

Fig. 37.—Hypopyon ulcer.

Suppuration of the Cornea, or Suppurative Keratitis, or Serpiginous Ulcer, is a very common disease and may occur at any age. As soon as an ulcer of the cornea becomes infected with pyogenic organisms it will commence to break down and become necrotic. Lymph will then collect in the anterior chamber, and this is called a hypopyon. The corneal ulcer may spread rapidly, and may lead to total destruction of the eye.

These cases always arise from an infected wound or a small abraded surface. The greater number are infected

from the purulent contents of a mucocele which the patient may have had for years; then he gets a foreign body into his eye or a slight abrasion which at once becomes infected and a hypopyon ulcer is the result. The pain caused by these deep ulcers is far less than that caused by a simple abrasion, owing to the fact that the nerve endings in the cornea are destroyed. Purulent infiltration of the interstitial substance of the cornea precedes actual necrosis, and in a short time perforation may take place, usually followed by a prolapse of the iris, and occasionally by panophthalmitis. It may occur at all ages, but is more common in children and in old people.

Treatment.—The ulcer must be at once scraped and painted with pure carbolic acid or be cauterized with the galvano-cautery. Atropine must be applied and constant hot bathing. The most important thing of all is to treat the cause if it can be found, and this more often than not is a mucocele leading to regurgitation of fluid from the lacrimal sac. The only efficient treatment for this is to dissect out the lacrimal sac, and so get rid of the source of infection (see p. 91). If the cornea is deeply ulcerated and much lymph is present in the anterior chamber, the best thing to do is to cut across the base of the ulcer with a narrow Gräefe knife after cauterization, and this tends more than anything to assist the healing process. Many of these ulcers will inevitably perforate, and it is far better to anticipate the perforation by incising in the most convenient place; this is called a "Saemisch section." The lymph in the anterior chamber may then be withdrawn. Should the ulcer heal, and should there be any clear cornea left, an iridectomy may assist the vision subsequently. Many of the least severe forms of hypopyon ulcer will heal after cauterizing them and the lymph will become absorbed. It is quite unnecessary to open an anterior chamber just because there is a hypopyon, for most of them consist only of lymph, which will readily become absorbed as soon as the ulcer heals.

A useful way to apply heat to these eyes is by means of a Japanese muff-warmer. A pad of cotton-wool is put on the eye, and one of these hot boxes is applied over the pad and kept in position with a bandage. It consists of a flat metal box in which a lighted cartridge is placed. The cartridge burns very slowly and produces a fair amount of heat, but never sufficient to be dangerous or uncomfortable. The patient must be kept in bed and well fed, and the general health should be kept in a satisfactory state.

FULL SIZE

Fig. 38. Broad needle.

In many pathological eye conditions subconjunctival injections of cyanide of mercury have given good results in the hands of some surgeons. It has been largely used for cases of suppurative keratitis. The strength of the solution used is 1 5000, to which a little acoine, 1 %, is added in order to reduce pain. About 10 minims of the solution are used, and the injection may be repeated every third day as long as necessary. Other remedies, such as cauterizing the ulcer, should not be neglected. This method of applying mercury as near as possible to the seat of injury in many cases acts quicker and more powerfully than when it is given by the mouth.

If a large hypopyon be present, and the case be not bad enough to warrant a Saemisch section, paracentesis may be employed. The usual method of doing this is to make a small incision with a broad needle at the corneoscleral junction, and then depressing the lip of the incision with a narrow iris repositor, thus allowing the anterior chamber to slowly empty itself. Sometimes the mass of lymph is so firm that it may be seized with iris forceps and drawn out. Small hypopyons will readily become absorbed when the ulcer begins to heal. The anterior chamber in these cases should never be looked upon as an abscess cavity which it is necessary to open as soon as purulent matter is seen inside. The

lymph which is visible is not pus, and but seldom contains living organisms.

Neuroparalytic Keratitis.—It is always a serious matter whenever the sensation of the cornea is obliterated, and especially is this the case when it is due to a lesion of the fifth nerve, which contains trophic as well as sensory fibres. Under these circumstances we have the combined effect of insensibility of the cornea, which allows of its surface getting dust and other foreign bodies on it, and also of its getting dry, without the patient knowing it. Probably the nutrition is diminished, and there may also be paralysis of the facial nerve which prevents the eyelid from being closed. These three circumstances acting together will with certainty lead to a keratitis, and perhaps to destruction of the cornea. Exactly how much effect the trophic fibres of the fifth nerve exert is open to considerable doubt, and much difference of opinion exists; but the facts as above stated are undoubted. This condition is seen after fracture of the base of the skull, in intracranial growths, and after any destructive lesion of the fifth nerve. The surgeon should always be on the look-out for it in cases of herpes ophthalmica.

Treatment.—By far the most important thing to do is to keep the eye closed. In mild cases this may be done by a pad and bandage, but should this not be sufficient no time should be lost in closing the lids by paring the edges and stitching them together. It will be sufficient if the middle, third or half of the lids be pared; the angles should never be touched. The lids may be kept closed as long as is necessary, and when it is required to open the eye again a snip with a pair of scissors will do all that is required. When paring the edges great care should be taken not to cut off more than is necessary, as troublesome trichiasis may develop if the hair bulbs are injured.

Should there be paralysis of the facial nerve without any affection of the fifth, it very seldom happens that

ulceration of the cornea takes place, and it is not necessary to stitch the lids together.

Complications following Corneal Ulceration.—Whenever there has been a corneal ulcer, a nebula corresponding to the size and depth of the ulcer will be left. This is nothing more or less than a scar, which at first is infiltrated, but later the infiltration absorbs and leaves the scar alone. However slight it may be, it always leaves some irregular astigmatism, which will greatly interfere with the vision, and which of course cannot be corrected with glasses. If it is dense it will obstruct the rays of light, and the eye may have its vision reduced in proportion to the depth and extent of the nebula. If the cornea has perforated, an adhesion of the iris to the back of the cornea is likely to take place, and this constitutes a *leucoma adherens* or an *anterior synechia.* Owing to the fact that the iris is drawn forwards, the angle of the anterior chamber will be narrowed or closed, and a secondary glaucoma will be the result. It is, therefore, advisable to divide these adhesions as soon as possible or to do an iridectomy (see pp. 139 and 148).

If the cornea has all but completely sloughed it will be impossible to separate the scar tissue which represents it from the iris, for the two will have grown together, thus producing obliteration of the anterior chamber. The tension rises, but as the scar tissue which takes the place of the cornea, though very liable to stretch, has no true elasticity, so it gets thinner as time goes on, until an anterior staphyloma is produced. This opaque structure will in time protrude so far that it is impossible for the lid to be closed over it. Owing to its exposed position it is particularly liable to injury and, sooner or later, a ruptured globe is the result. It is far better to excise such eyes before they get to this stage, and as the eye is blind, the patient losses nothing by having it removed. From exposure and disease these eyes are always more or less irritable and painful, and they may cause sympathetic ophthalmitis.

If the eye perforates suddenly and the vessels are atheromatous, a choroidal vessel may give way and will lead to a complete detachment of the choroid and retina. This will cause a good deal of pain, and the sooner the eye is excised the better.

If the ulcerated cornea and the lens remain in contact for some little time after perforation an anterior polar cataract will be the result.

Calcareous Degeneration of the Cornea.—This occurs in old and degenerated eyes, such as those blind from glaucoma or cyclitis. The rough deposit on the cornea is sometimes very irritating, and should be scraped away with a spud and treated like a foreign body. Such calcareous deposits may extend right across the cornea.

Fig. 39.—Calcareous degeneration of cornea.

Arcus Senilis is a ring of greyish opacity, which partially or entirely surrounds the cornea at the periphery. It is more commonly seen in old people, as its name indicates, but it not infrequently is present in young adults, and sometimes even in children. No defect of vision is produced by it. It never reaches the pupillary area. It in no way interferes with the healing of an iridectomy or extraction wound, and although it is usually looked upon as a senile change, yet it frequently occurs in people in the best of health, and may be there for years without the patient showing any other signs of degeneration. It is doubtful what causes it; it may be a hyaline change. Some say it is fatty, but it

does not stain histologically with osmic acid. It never disappears and no treatment has the slightest effect upon it.

Conical Cornea, or Keratoconus, is a curious condition, in which the central portion of the cornea is drawn out in the shape of a cone. It remains clear, except in extreme cases, but gradually gets thinner and thinner as it bulges more and more forwards. This alters the refraction of the eye considerably, and produces an extreme degree of irregular astigmatism. It usually makes its appearance about the age of puberty, or between that and twenty-two or twenty-three years of age, and when once present it goes on increasing, until but little useful vision remains. The apex of the cornea may become so thin that the slightest injury will produce a rupture, while its nutrition may be so affected that the apex becomes opaque.

FIG. 40.—Conical cornea.

Pathology.—It is probable, as first suggested by Tweedy, that it is a developmental defect. The mesoblast, which forms the interstitial substance of the cornea, is defective, and this leads to weakening of the structure. Now while the coats of the eye are soft and growing, they all expand equally, but after the sclera becomes more dense the weak cornea is unable to withstand the normal intraocular tension and it becomes bulged, while the more it bulges the weaker and thinner it becomes. This theory is rendered the more probable as congenital defects of the eye

and other parts are sometimes found in association with it, but by no means always.

Diagnosis.—A well-marked case is easily visible to the naked eye, especially in the dark room and with oblique illumination.

If the fundus be examined with the direct or indirect method, great distortion of the disc and vessels is noticed. If a retinoscopy mirror be used shadows will be seen running in the most irregular manner all over the cornea; and on giving a circular movement to the reflected light on the eye an appearance as of a wheel in motion is seen.

At the periphery of the cornea, where the illumination is the brightest, the shadow goes round like the rim of a wheel, while at the centre the reflex is much more dull and appears to move slower. A very distorted image is seen with a Placido's disc or with a keratoscope.

It is quite impossible to do a retinoscopy or to form an idea as to whether any lens will improve the patient's vision, but it generally happens that some glass will be found which will help matters, but this can only be ascertained by trial. It sometimes happens that a high cylinder set at some particular angle, either alone or combined with a spherical glass, will cause considerable improvement; and usually a high minus cylinder is chosen. If such a glass can be found it may be ordered purely on the strength of what the patient sees, for there is no other means of determining what really corrects the refraction. Inasmuch as the refraction differs at every possible place on the cornea, it is manifest that no lens could be made which would correct the error, and one has to be content if one can find a glass which will materially improve the sight.

Operative Treatment.—Various operations have been devised to bring about flattening of the cornea, but as the only thing likely to do any good must be performed on the apex of the cone, it is bound to produce a central nebula.

An Elliptical Piece of the Apex of the Cone may be

excised.—In order to do this cocaine is applied, and a very thin Graefe knife is used to transfix the apex. The knife is then made to cut outwards and forwards, and the resulting incision is about three millimetres long. The aqueous has by this time escaped. The edge of the flap is next seized with a delicate pair of straight iris forceps, and a piece is cut off with scissors, so that the resulting hole is oval in shape. Atropine is applied and the eye is closed.

Galvano-cautery.—This may be applied to the apex of the cone, and may be made to perforate the cornea or not as desired. If perforation is accomplished the result is very much the same as if the apex were excised. If the cornea be not perforated, although much flattening occurs at the time, yet it is likely to become nearly as conical afterwards as it was before. In order to overcome this, some surgeons are in the habit of doing paracentesis of the anterior chamber every two or three days for a fortnight, until the weak scar has healed sufficiently to prevent the intraocular tension bulging the wound. Atropine must be used the whole time.

The worst of a perforating operation is, that it sometimes takes a long time for the anterior chamber to reform, and atropine has but little effect upon the pupil until this takes place; the result is, that the iris and lens are so long in contact with the wounded cornea that an anterior synechia is liable to be produced, and perhaps an anterior polar cataract as well. Sometimes the wound heals quite quickly, but at other times the anterior chamber will be absent for several weeks, and during the whole of that time the possibility of infection of the eye from without is a very real danger. Probably the non-perforating operation with the galvano-cautery is the safest, but it is sometimes impossible to prevent perforating as the cornea is so thin. The cautery should be used only at the dullest red heat; if used much hotter than this, perforation is certain to take place whether it be desired or

not. Some surgeons prefer to use a small cautery composed of solid metal, which can be heated to any desirable temperature in the flame of a spirit lamp (Fig. 41).

Should the resulting scar be very dense, an optical iridectomy may help matters later on. It is sometimes astonishing what excellent results are obtained, but it is quite impossible to predict what will be the result of the operation. Possibly no improvement at all, possibly almost normal vision. In a bad case an operation is worth trying if optical means fail.

Keratomalacia.—This is a destructive inflammation of the cornea which occurs in badly nourished children, and is often associated with xerosis of the conjunctiva. It usually occurs during the first year of life. The cornea very quickly becomes ulcerated and necrosed, and finally perforates, the eye being totally lost. Usually both eyes are affected. The actual cause of the disease is unknown. The children who get it are all very badly nourished, and although it is said by some to be of syphilitic origin, it is more than probable that if syphilis has anything to do with it at all, it is purely secondary, and acts only by lowering the vitality of the patient.

FIG. 41. Cautery.

Treatment.—The eyes are always lost in this disease, and the children are usually so badly nourished that death occurs. Good food, hot bathing, and general treatment must be employed.

Keratitis Punctata is described under the head of Iridocyclitis, of which it is a symptom. It consists of dots on the back of the cornea, and is not really a true keratitis at all (p. 124).

Interstitial Keratitis, or Parenchymatous Keratitis, is a disease which in by far the greater number of cases comes on in children who are the subjects of congenital syphilis, but it sometimes is the result of tubercular disease. As a rule it is not a primary disease of the cornea, but the

cornea becomes affected as the result of a severe iridocyclitis. It is important to remember that the ciliary body, the iris, the interstitial substance of the cornea and the choroid are all developed from the mesoblast, and as syphilis always attacks mesoblastic structures, so all these parts of the eye are liable to be affected in any syphilitic manifestation. Inflammation starts in the ciliary body, and spreads forward, giving rise to iritis and keratitis, or backward and then causing choroiditis. As the affection of the cornea is such a very marked feature of the disease it will be convenient to consider it here.

There is no doubt about the fact that congenital syphilis is the cause of about 70 % of these cases. It usually attacks children between about five and fifteen years of age. Most of these patients have the typical facial and dental characteristics of congenital syphilis. Sometimes interstitial keratitis does not develop until the patient is a good deal older, between twenty and thirty years of age. Although it frequently comes on without any obvious exciting cause, it sometimes follows an attack of phlyctenular conjunctivitis, or some more or less trivial injury to the eye. Both eyes are nearly always involved; sometimes the two eyes run through the attack together, at other times one eye has finished its course before the other shows signs of becoming affected, and this renders the illness a very long and tedious one.

Symptoms.—If the case be seen in the very earliest stage of the disease, all that will be noticed is a faint ciliary blush with slight irritation of the eye. If the patient is old enough it will generally be ascertained that there is some slight blurring of the sight. On more careful examination dots of keratitis punctata may be seen; and these consist of a collection of small round cells adherent in little pyramidal-shaped masses to the back of Descemet's membrane (Fig. 44). These cells come from the ciliary body, and are a sure sign of cyclitis. Even if no keratitis punctata is visible the aqueous will be turbid, and the cornea becomes

infiltrated with inflammatory cells and exudation, while there may be some tendency to the formation of posterior synechiæ. Should adhesions have formed they will probably break down if atropine be applied. This is the first stage, or the stage of infiltration. This lasts for a month or six weeks, when the stage of vascularization is entered upon. Vessels begin to develop in the interstitial substance of the cornea, and push themselves in every direction. They are very fine, but may be so numerous that a part, or the whole, of the cornea assumes a pink-flesh colour, and this is termed a "salmon patch." There is intense injection of the ciliary region and conjunctiva, the eyes are very painful, and there is frequently marked photophobia. The cornea will by this time be so obscure that the patient can see nothing more than light from darkness, while the iris is quite invisible to the observer. So bad may the eye look that it is difficult to believe that there will ever be any useful sight unless one is familiar with the wonderful way in which these eyes clear later in the disease. After six or eight months or more in this condition the third stage of resolution commences, when the vessels gradually diminish in size, and finally cease to carry blood; the infiltration subsides, the cornea clears, the iris becomes visible, and the sight improves. Sometimes, after the most severe attack, the cornea will clear so thoroughly that to a superficial examination nothing abnormal may be seen; but in a dark room, and with a plane mirror of an ophthalmoscope backed

FIG. 42.—Interstitial keratitis. Pannus and "salmon patch."

up with a + 20 lens, the remains of vessels will always be visible; they never completely disappear, though they are no longer active. It is important to remember this, as it may be of value in determining the probable state of the eye previous to an alleged accident. The stage of resolution will go on for two or three years, after which no more clearing will take place, though very often there is scarcely anything left to show what severe trouble the eye has had, but occasionally the cornea is left permanently nebulous. The disease comes on, though rarely, after acquired syphilis in the adult. It is a tertiary manifestation, and as a rule only one eye is affected. It has been seen in children after acquired syphilis, when, for instance, the infant has had a primary sore, say on the eyelid, as the result of infection from a nurse.

In most cases iritis is present, and very often choroiditis as well.

Etiology.—The vast majority of cases are due to syphilis, but tubercle is responsible for some, and possibly other causes leading to bad health.

Prognosis.—This is usually good, and it is wonderful how a cornea may clear after such a severe disease. It must, however, be remembered that the nutrition of the eye is seriously affected, and should an injury occur, or an ulcer develop, the chances are that the eye will be lost. The iris must never be forgotten although it cannot be seen, for unless atropine be used the whole time a blocked pupil will result. Tension must be carefully watched. If it goes up and is not relieved the sight may be lost from unrecognized secondary glaucoma. Again, it must be remembered that the choroid is in direct connection both anatomically and morphologically with the ciliary body and cornea, and it is very likely that while the cornea is opaque a choroiditis is present as well, and this may cause a serious defect of sight, or complete blindness, after the cornea has cleared. It is, therefore, never desirable to look upon the disease lightly, but the sight recovers

in most cases, so that too hopeless a view need not be taken.

Treatment.—Inasmuch as syphilis is responsible for by far the greater number of cases, the obvious treatment is to give mercury. This should be administered all through the disease, but if there is much anæmia it may be combined with iron. Children may take gr. ij or iij of grey powder a day, and if combined with about gr. ss of powdered belladonna leaves it is less likely to act on the bowels. Tonics should be given. In the acute stages iron does not help much, but rather appears to increase the photophobia, like it certainly does in phlyctenular conjunctivitis. Locally atropine must be instilled the whole time, so as to keep the pupil dilated, or posterior synechiæ are sure to develop. Hot bathing gives relief, and a large shade which protects the eyes from light, or dark glasses, will make the patient more comfortable. The eyes should never be tied up.

Should the tension of the eye rise and secondary glaucoma supervene, paracentesis of the anterior chamber should be done as often as necessary (see p. 110). Iridectomy would be worse than useless in the acute stage. It may be necessary to perform this operation, for a blocked pupil, when the eye is quiet.

If the condition be due to tubercle, atropine and hot fomentations must be used locally, and general treatment directed towards the curing of the disease and the prevention of its spread.

Vascular Keratitis, or Pannus, is always a secondary condition. As has been seen, it forms the second or intermediate stage of an interstitial keratitis, and here the vessels are in the interstitial substance of the cornea (see Fig. 42).

Strands of vessels frequently run from the margin of the cornea to an ulcer which may be present, while a very considerable development of vessels takes place during the course of an attack of trachoma. The upper part of the cornea is usually the most affected. The

vessels are much more superficial than those of interstitial keratitis, and are in the subepithelial layer of the cornea.

Treatment.—As a rule these vessels may be left alone, because they are really concerned with the repair of the cornea; thus in an interstitial keratitis it is chiefly due to them that the nutrition is maintained, and they also supply the phagocytes which clear away the inflammatory products. The same may be said with regard to trachoma. Some surgeons perform peritomy, which consists of excising a ring-shaped piece of conjunctiva and subconjunctival tissue about three or four millimetres wide from the immediate vicinity of the cornea; scar tissue takes its place and obliterates the vessels. It is very doubtful whether this does not prevent rather than aid subsequent clearing of the cornea. If a strand of vessels runs towards an ulcer it may be cut across with the galvano-cautery or painted with pure carbolic acid at the same time that the ulcer is being cauterized. The irritation of the eye is sometimes much reduced by this method.

CHAPTER VII

DISEASES OF THE UVEAL TRACT

THE iris, ciliary body and choroid are morphologically one structure, and are all developed from the mesoblast. So closely are they associated that it is unusual to get one of these structures inflamed or diseased without the other two being more or less affected. They are supplied by the same vessels and nerves, and have so many things in common that it is convenient to consider them together. It is not necessary that every case of iritis should have choroiditis as well, and we frequently get choroiditis without any visible sign of iritis, but as the ciliary body is the structure which more than any other presides over the nutrition of the eye, and is, as it were, the central station for the whole of the uveal tract, so we find that in most inflammatory affections the ciliary body is more or less involved, and very often it is the starting-point of the whole process.

Cyclitis, or Inflammation of the Ciliary Body.—The ciliary body is frequently the seat of inflammatory changes, which, if they spread forwards and affect the iris, the condition is called iridocyclitis; and if backwards to the choroid, iridochoroiditis. Syphilis has a peculiar aptitude for attacking the ciliary body, and so also have many toxæmic conditions.

Serous Iridocyclitis is usually present in cases of interstitial keratitis and in many septic and toxæmic conditions. The ciliary body is first affected, and this leads to serous exudation containing a good many cells. These find their way into the aqueous, and become

collected into groups and adhere to the back of Descemet's membrane. They vary in size very much, and the condition is called *keratitis punctata* (Figs. 43 and 44), though really they have nothing to do with the cornea, but only adhere to it because it is there and ready for them to become attached to.

If there are still more cells present they collect at the lower part of the anterior chamber, and are visible as a hypopyon. It is well to remember that the hypopyon lies at the bottom of the anterior chamber simply by the action of gravity, and if the patient is recumbent the cells become spread all through the aqueous, and are no longer visible. Should the inflammation be still more acute, blood may become exuded into the anterior chamber forming a hyphæma.

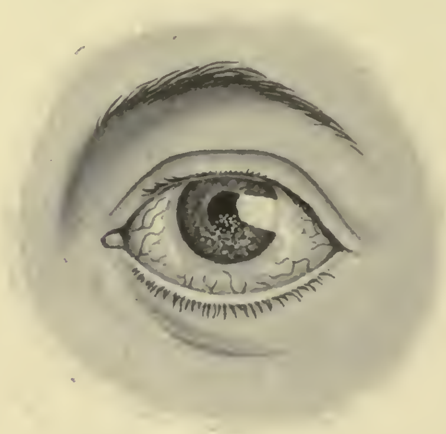


Fig. 43.—Keratitis punctata.

If the exudation is still more abundant it will permeate the vitreous and produce vitreous opacities and choroiditis. All these acute conditions may result from syphilis, gonorrhœa, pyorrhœa alveolaris, and all forms of general septic disease; they are often associated with arthritis, rheumatism and gout, while some of the worst cases are seen as the result of wounds of the eyeball with direct infection. Sympathetic ophthalmitis is an example of the most severe type of cyclitis that it is possible to get. Owing to its quickly spreading to the iris, and other parts of the eye, a pure cyclitis is not very often met with. Its symptoms are: very deep ciliary injection, the circumcorneal

zone looks as if it had been painted red with a brush, and the individual vessels are scarcely to be made out; the eye is acutely tender, the anterior chamber is deep, and, owing to the abundant secretion of aqueous, and because of the lymph and cellular exudation, the spaces of Fontana become blocked and the tension rises, thus causing a condition of secondary glaucoma. This thick and plastic

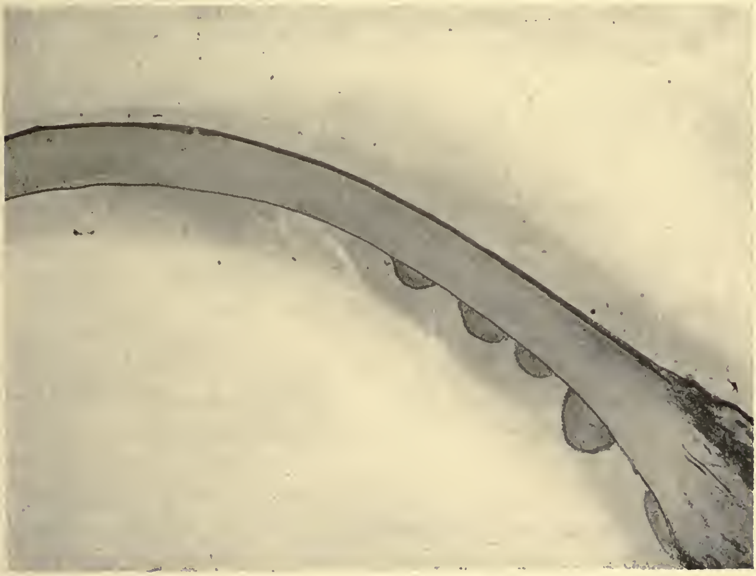


FIG. 44.—Keratitis punctata.

secretion may be so abundant that the iris adheres to the lens capsule and the pupil becomes blocked, thus producing total posterior synechia. After a time the ciliary body is so damaged by the inflammation that instead of secreting too much fluid it fails to secrete enough, and then we get a soft eye and this is the first stage towards the development of a shrinking globe, or *phthisis bulbi.*

It entirely depends upon the violence of the symptoms, and the length of time they have been present whether

we call it acute or chronic cyclitis. If an acute case does not quickly subside it is very liable to drift into the chronic form, and the result is generally a shrunken eye and an opaque lens.

In tertiary syphilis it is not very uncommon to get a gumma developing in the ciliary body, and although an iridocyclitis is produced, it is very different in character from the syphilitic iritis, which is so often seen during the secondary stage of the disease.

Tubercle also affects the ciliary body, and a mass develops which, as far as appearance goes, might be a gumma, but we have the history to guide us here. The iris and choroid are always involved sooner or later. After long-continued cyclitis the sclera adjoining the ciliary body becomes thin and of a bluish colour, and very often bulges at places, thus producing ciliary staphylomata.

Treatment.—The treatment of cyclitis is precisely that of iritis. The disease which gives rise to it must be cured if possible; while, locally, atropine, hot bathing and fomentations, as well as the application of leeches and counter-irritation, must be used with care and discretion. This will be treated of more fully when discussing iritis, to which section the reader is referred.

Iritis.—This disease is characterized by intense pain, not only of the eye but radiating all round the forehead, the malar bone and the side of the nose. The ciliary region is intensely injected, the iris loses its lustre and becomes muddy in appearance, and on carefully examining it with the oblique illumination and the loupe, vessels may be seen running all over it. The pupil does not react and is small, while its edge has an ill-defined margin, due partly to the fact that it is swollen and œdematous, and partly because adhesions are forming between it and the lens capsule. The aqueous is turbid, and the pupillary area may be occupied with lymph. The sight is considerably affected and the eye is very tender. The congestion of the iris and ciliary body may be so severe that hæmorrhages

may be present on the surface of the iris, and if still more intense, blood may exude and collect in the anterior chamber and form a hyphæma. At other times the exudation of lymph and cells is so great that a hypopyon is produced. Occasionally in a severe attack of serous iritis a mass of jelly-like exudation will collect in the bottom of the anterior chamber, and this sometimes assumes a lenticular shape and looks remarkably like a dislocated lens.

Diagnosis.—An early iritis may be mistaken for conjunctivitis, and it is of the utmost consequence to distinguish one from the other. The position of the injection in the two diseases is quite different. In iritis it is circumcorneal, and the fine vessels here give the appearance of a painted ring round the limbus, whereas in conjunctivitis the injected vessels are superficial and large, and can each be seen individually. In a severe iritis both sets may be affected, but the deep ciliary injection is by far the more important, and if this is present the case is one of iritis. In addition to the contracted pupil, the altered appearance and colour of the iris, and the more or less immobile pupil, point to iritis. Even more important is it not to mistake a case of iritis with one of glaucoma. In the latter the pupil is dilated, the anterior chamber is shallow, the cornea has a superficial appearance very different from a case of iritis, and the tension is high. The history of the case and the appearance of the other eye will frequently give valuable assistance. Too great importance cannot be attached to a correct diagnosis in an early stage. If astringents are given with the idea that it is conjunctivitis all the symptoms will be increased; while if eserine be used no better example of adding fuel to fire could be given; the iris will be contracted and still further injected, posterior synechiæ or adhesion of the iris to the lens capsule will be actively helped to form, and probably no amount of atropine used subsequently will again open up the pupil. Eserine, which will reduce

the tension in a case of glaucoma, will actually produce a condition of secondary glaucoma in iritis.

Etiology.—Iritis is seldom or never a primary disease, but usually follows some toxæmia, due to either syphilis, sympathetic ophthalmitis, gonorrhœa, pyorrhœa alveolaris, any septic condition of the mouth, nose, nasal sinuses, or genito-urinary tract, tubercle, chronic suppuration, gout, nephritis, diabetes, rheumatism, and any acute specific diseases, such as enteric fever, scarlet fever, etc. It frequently is traumatic in origin, due to a wound of the eye, and sometimes it develops after a blow without penetration. Should there be a simple hyperæmia of the iris it may be converted into a true iritis by the use of astringents, such as sulphate of zinc or alum used under the mistaken notion that the case is one of conjunctivitis only.

All cases of iritis may be roughly divided into two main groups—(1) plastic, (2) serous. The division between these groups is very arbitrary, but it may be said that the plastic iritis cases are represented by the sympathetic and the syphilitic, in which there is the greatest tendency to the formation of posterior synechiæ with blocked pupils; while as a type of the serous iritis may be mentioned the rheumatic variety, which includes all those of septic origin, especially those due to gonorrhœa, in which there is much fluid exudation with a deep anterior chamber and keratitis punctata.

Syphilitic Iritis.—This is a violent form of plastic iritis which occurs during the secondary stage of the disease. There is intense ciliary injection, a varying amount of pain, though sometimes violent; a muddy-looking iris with an anterior chamber of about normal depth. From the first there is a great tendency to the formation of posterior synechiæ due to the fibrinous nature of the exudate which is poured out into the anterior chamber. Unless prompt measures are taken to get the pupil fully dilated and to keep it so, posterior synechiæ will form and before long

the whole pupil will be blocked. So great is the tendency for the pupil to get bound down, that it seldom happens that this disease runs its course without there being permanent marks left behind, which will for ever afterwards tell their tale, such as posterior synechiæ, or detached uveal pigment on the lens capsule. There is very little tendency for this form of iritis to recur. The usual course of the disease is one very severe attack and no more. There is, however, another variety of iritis which comes on as the result of syphilis, but that is a late tertiary manifestation, and occurs where a gumma develops in the ciliary body or iris (Fig. 46). This, however, has nothing to do with the iritis which occurs either early or late in the secondary stage. Iritis is nearly always present in cases of interstitial keratitis, and this is in most instances due to congenital syphilis.

FIG. 45.—Plastic iritis with posterior synechiæ.

Rheumatic Iritis.—The word *rheumatic* here is used in its broadest sense, and includes all cases due to septic diseases and toxæmias, and the most common cause of this condition is gonorrhœa. Although iritis has been known with acute rheumatism, yet it is so rare that some authorities deny its existence, and say that all cases of iritis in which arthritis and rheumatism are present, are really gonorrhœal or septic in origin and not the result of acute rheumatism. Be this as it may, the fact remains that by far the greater number of cases of rheumatic iritis occur in patients who have had gonorrhœa, and

most of them have suffered from undoubted gonorrhœal rheumatism.

The characteristics of this form of the disease are quite different from the syphilitic cases. It is essentially a serous iritis; keratitis punctata is present, there is much fluid exudation in the anterior chamber, and very often a certain amount of coagulated jelly-like substance. Hæmorrhages in the iris are fairly common, and a hyphæma is by no means rare. The pain is often intense, the tension may be raised, but the most characteristic feature of the disease is the great tendency it has to recur. Attacks may come on so frequently and with such severity that the patient's life is almost a burden to him. This never happens with syphilitic iritis, but it must be remembered that a patient who has had syphilis may have had gonorrhœa also, and so a mixed infection may be present. These recurrent attacks may continue for years after infection, and some patients never seem to wear out the poison, and every few months they get a fresh attack until the eye may be blinded thereby. It is certainly the most troublesome, and in some ways the most serious, form of iritis, though each individual attack seldom does as much harm as the single attack which occurs in syphilis.

Iritis following Pyorrhœa Alveolaris and other Septic Conditions of the Mouth or Nose.—This is a class of case which, until recently, had not received due recognition. At one time every case of iritis which was not obviously syphilitic was put down as gouty or rheumatic, and if the patient had not suffered from either disease it was generally considered that he had probably only just missed them or would develop them later. No case of iritis ought to be considered idiopathic, for nearly always a satisfactory explanation of it will be found if it be looked for, and the mouth is a very potent source of infection. If there is a single carious tooth it should be removed or stopped, but if pyorrhœa alveolaris (Riggs's disease) be present, prompt measures must be taken to

cure it, which are seldom successful without removing the teeth. It must never be forgotten that in striving to save diseased teeth the sight may be severely damaged or destroyed. If the nose or sinuses are subject to chronic suppuration this must be treated without delay.

Tubercular Iritis comes on in persons who are the subjects of tubercular disease, and is seldom if ever a primary lesion. It appears in different forms: (*a*) as a yellowish growth in the ciliary body and iris; (*b*) as miliary tubercle of the iris, usually situated near its base (both these forms are apt to run a quiet or more or less quiescent course); (*c*) as a violent iritis, often with keratitis as well, and appearing in the form of a tubercular interstitial kerato-iritis—in this form also nodules are frequently present.

FIG. 46.—Gummatous iritis.

It is often difficult to distinguish these cases from those due to syphilis, but the course and history as well as the general appearance of the patient, and also the family history, are of value. As a further aid to diagnosis Koch's old tuberculin may be used, and if with a negative result the presence of tubercle may be excluded. The Calmette reaction ought never to be used. It is far too dangerous, and has been almost if not universally given up, and need not be further described.

Treatment.—All cases of iritis may be treated on similar lines locally, but having once ascertained the cause of the disease, this must be vigorously treated as well.

Every case requires a mydriatic at the earliest possible moment. Unless the pupil is enlarged at once it will probably never be dilated afterwards.

The best and cleanest way of using atropine is in the form of drops of 1 %. If a very strong action is required an ointment may be used consisting of 2 % atropine and cocaine, while perhaps the most vigorous way in which the drug can be applied is by placing a crystal or two of the pure atropine on to the lower lid and letting this dissolve. If this will not dilate the pupil nothing will, but it must not be discontinued though the effect in the pupil be small, for if it is it will contract still more, and the smaller it gets the greater is the chance of its becoming blocked. There is one caution necessary when using atropine freely, and that is that it is extremely toxic to some people. First the throat and nose become dry, then the patient becomes apprehensive, he fancies people are under the bed, he picks at the bed-clothes, and unless the drug be promptly stopped he soon passes into a stage of violent delirium. If he can get hold of a knife or weapon he will endeavour to stab or injure any one who comes near him, for he is under the impression that he is going to be murdered himself. Morphia may be given hypodermically, but the patient often has to be overpowered before it can be administered. This state of things ought seldom to occur, for there are always premonitory symptoms which if looked for can be recognized. It should be remembered that coma may result from atropine poisoning, so that it is not very safe to give a large dose of morphia to quiet the patient, though very small doses are of little use. Poisonous symptoms are seldom seen with 1 % drops used three or four times a day, but 2 % must be used with caution, and pure atropine had better not be applied more than once or twice except after a long interval. Atropine sometimes causes a very severe eczema of the skin, of the face and eyelids. If this occurs it must be left off, and ¼ % duboisine or ½ % hyoscine should be used instead; the skin will

probably tolerate one or other, but they are both very toxic drugs.

Hot bathing will give far more relief from pain than anything; cold applications should be avoided, as they lower vitality and do no good. The Japanese muff-warmer strapped over the eye, which is protected with a large pad of wool to prevent its burning the skin, is a most useful way of applying dry heat. If hot bathing be used it should be applied at a temperature a good deal higher than can be borne by the fingers. It is astonishing what heat an eye can stand if worked up to it. The best way is to have a basin of very hot water or boracic lotion, and in it to place a large piece of cotton-wool; this may be applied to the eye by means of the bowl of a wooden spoon, the handle of which the patient can hold, and thus save his fingers from the pain of the very hot water. In almost all cases of iritis mercury is useful, whether it be syphilitic or otherwise. For the intense pain which is sometimes present there is nothing so good as bleeding. A couple of leeches applied near the outer canthus often do great good, and many a person can be relieved of his pain very quickly by bleeding from the median basilic vein. After this the pupil often dilates with atropine which previously had little or no effect on it, while the patient will perhaps sleep for hours as soon as this happens after nights and days of suffering. If the pain be very severe morphia may be given, but in any case the bowels should be freely opened with a mercurial purge followed by a saline.

The disease which is responsible for the attack must be actively treated.

Choroiditis.—Inflammations of the choroid are usually associated with exudation, and all stages are seen, from the slightest disturbances to acute purulent inflammation. The cases are often classed in two groups, suppurative and non-suppurative.

Suppurative Choroiditis is a severe affection which

in most cases leads to panophthalmitis. Sometimes, however, the inflammation is less acute, especially in children, when it gives rise to an appearance so like glioma that it is called pseudo-glioma. Acute suppuration of the choroid and the whole uveal tract is generally due to an infective wound, and very often to the presence of a foreign body within the eye, which leads to rapid disorganization of the whole globe.

It sometimes occurs as the result of a septic embolism in general pyæmia and ulcerative endocarditis. Occasionally it follows a wound of an eye which has healed with the inclusion of a piece of iris, ciliary body, or lens capsule in it. This forms a direct communication with the interior, and if such an eye gets an infective conjunctivitis it may lead to a destructive, or a suppurative, iridocyclitis.

In children, when it assumes the variety known as pseudo-glioma, suppuration is much less violent; so much so that the eye may show scarcely any signs of inflammation, and it is only later on, when the retina is detached and the back of the eye is disorganized, that the white pupillary reflex so like a true glioma is seen. In these cases there is generally some retraction of the iris at its base, and other evidence which may make it tolerably clear that the white appearance is really of an inflammatory origin; still it is sometimes impossible to decide for certain before the eye is excised.

Treatment.—In this disease the sight is never saved, and the globe is as a rule not worth preserving, for it is sure to become shrunken and shrivelled, and most likely painful, so that it will have to be excised. Opinions differ as to the best method of dealing with an acutely suppurating eye. Some say that it should not be excised for fear of producing septic meningitis, others hold that such eyes should be excised as quickly as possible for fear that the pus should find its way back and infect the meninges. It is true that cases of septic meningitis have been seen in

which the symptoms came on after excision, but this is no proof that it was the excision which caused it, for meningitis may be present days and weeks before symptoms develop, as is seen, for instance, when extensive meningitis is found *post mortem*, when symptoms showed themselves a few hours only before death. Rather does it point to the fact that the excision was delayed too long. If, however, it is quite certain that the eye cannot be removed without its bursting and scattering its purulent contents over the bleeding orbital tissues, it is far better to eviscerate first, and after the pus has all been washed away the sclerotic may be removed with greater safety. It stands to reason that nothing but danger can arise from keeping pus shut up in an eye which is in direct communication with the brain, and with the rest of the body by means of blood-vessels and lymphatics.

It is sometimes extremely difficult to distinguish between a pseudo-glioma and a true glioma, and as in both the sight is hopelessly lost, and as it would entirely destroy the chances of saving the life of the patient if a true glioma were left under the impression that it was a pseudo-glioma, it is far better to excise these eyes at once.

Non-suppurative or Exudative Choroiditis is nothing like so destructive as the suppurative variety. It occurs as disseminated choroiditis in tertiary syphilis and in tubercle. Some cases are congenital, and others are due to suppurative and infective diseases, such as pyorrhœa alveolaris and other septic conditions of the mouth, nose, genito-urinary system, etc. In progressive myopia central choroiditis is very likely to develop, and this is usually associated with retinal changes. It is almost impossible to get a choroiditis without getting some retinitis from direct spread of the disease. Central guttate choroiditis is frequently present as a senile degeneration, and similar changes are sometimes associated with diabetes and nephritis. Other cases appear to come on without any ascertainable cause.

Symptoms.—Failure of sight is the chief symptom, but this varies much in degree with the position and extent of the affected parts. If the macula is extensively involved, almost total blindness will be the result. If the patches are small, distortion of objects may be the first sign, while wherever an affected area is situated a scotoma will be present in that portion of the field. Night-blindness

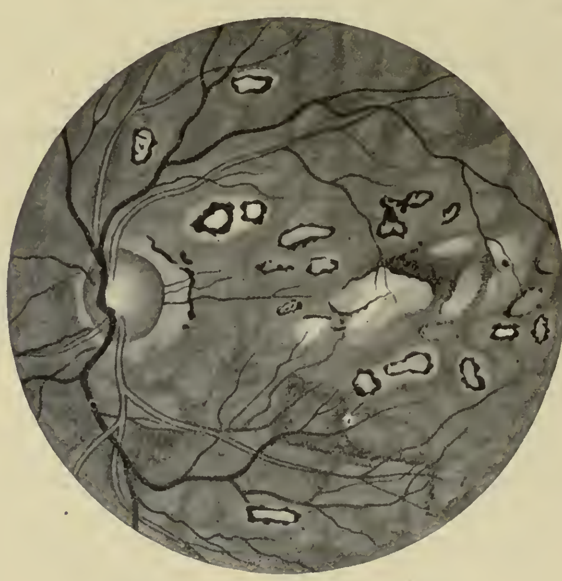


Fig. 47.—Disseminated choroiditis.

is often a marked symptom. Total blindness sometimes results from an extensive choroiditis followed by secondary atrophy of the optic nerve and retina, and sometimes also the lens becomes opaque from nutritional changes. Ophthalmoscopically the appearances vary enormously. In the early stages yellowish spots of exudation may be seen with œdema round them. As these spread they may become confluent, and after a time large areas are left where the sclera is seen through the atrophied tissues, while the pigment is heaped up or surrounds the white

patches. In senile choroiditis and that due to Bright's disease the changes are much finer, and are not generally pigmented; they are sometimes so minute that they are only visible with the direct ophthalmoscopic examination. Choroiditis presents the most diverse ophthalmoscopic pictures, and no two cases are really alike except in broad outline.

Treatment.—This consists of treating the disease which is responsible for it if possible. Little or nothing can be done for the senile cases, which are really of a degenerative nature. For syphilitic cases and all those which are not due to kidney disease, mercury will have a beneficial effect. It may be administered by the mouth, by inunction, by subconjunctival or subcutaneous injection. In spite of all treatment the sight is likely to be severely affected.

Injuries of the Iris.—The iris is usually injured by means of a punctured wound of the cornea, which may penetrate deep enough to cut it, but even if the object causing the injury does not actually touch the iris, it frequently allows an escape of aqueous, which carries it into the wound, where it becomes caught and nipped. A curious fact about the iris is this, that when it is incised the wound never heals. Should a severe iritis supervene, the cut edges may be glued together by inflammatory material, but a clean-cut wound remains and never closes, neither do the edges of the coloboma develop scar tissue. If the cut extends into the pupillary area it gapes, and a coloboma is left just as if an iridectomy had been done. If the iris is pricked the hole does not close. Small foreign bodies which have penetrated the cornea frequently get entangled in the iris and cannot well be separated from it. Such injuries nearly always wound the lens as well.

Concussion injuries, such as a blow from a large blunt object, may tear the iris from its attachment, thereby producing an *iridodialysis*, or the iris may be split radially. These injuries seldom if ever heal. Frequently a blow

will produce a permanent mydriasis or dilatation of the pupil.

Treatment.—A prolapsed iris is a most dangerous thing to leave, for the iris forms a direct communication from without to the interior of the eyeball, and suppuration or sympathetic irritation or inflammation is more than likely to occur. It must be got rid of at the earliest possible moment. If the case is seen immediately after the injury and the iris is only just caught in the wound, the vigorous application of atropine may liberate it, but it is very rarely that it succeeds in doing this. Atropine should in all cases be applied at once, and if the iris is really prolapsed it must be removed. This is one of the most difficult operations to do properly, and one of the most urgent. Inasmuch as the pain caused by pulling on the iris is severe a general anæsthetic must be used. The eye is carefully washed and the prolapsed iris is gently loosened from the wound. A broad pair of capsule forceps with four or five teeth on the under-surface must then be laid on the cornea, and made to grasp the whole of the prolapsed iris; and when it is quite certain that it is well liberated from the lips of the wound the forceps are raised and the iris is very considerably stretched. When it is stretched excessively, and as much as is possible without actually tearing it, a pair of De Wecker's scissors are laid flat on the cornea and the iris is divided with one snip. Owing to the great tension, the moment the scissors are closed the iris retracts like a piece of cut elastic and springs back into the anterior chamber well away from the incision. The surgeon has one chance—and only one—to get things clear, and unless the iris retracts by itself it will not be possible to free it from the wound. It is for this reason, and because of the considerable tension which is necessary to put upon the iris, that a local anæsthetic should not be used; if it is,

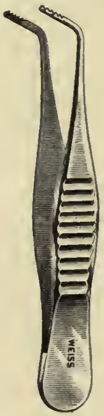


Fig. 48. Capsule forceps.

the pain becomes too acute to be borne, the patient moves, and the iris is sure to be cut before it is sufficiently stretched to ensure its retracting as it should. Atropine must be continued until the eye is quite quiet.

It has been recommended by some that if the wound of the cornea be peripheral and a prolapse has taken place, eserine should be used to endeavour to withdraw it. Such treatment ought never to be employed. The iris will almost certainly not be liberated, but as there is bound to be some traumatic iritis, this will be increased and a blocked pupil will be the probable result. *Atropine should always be used.*

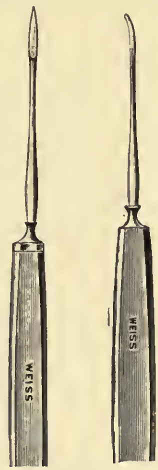


Fig. 40.—Lang's twin knives.

Anterior Synechia.—This is caused as the result of a perforating ulcer or wound, and consists of the adhesion of the iris to the back of the cornea. The danger of this consists in the fact that it pulls the iris forwards, and is very likely to lead to secondary glaucoma by blocking the angle of the anterior chamber. In addition there is always a drag on the iris and ciliary body when the pupil acts, and an eye which is wounded will often quite refuse to quiet down while the adhesion remains. So soon, therefore, as the wound is closed sufficiently to allow of it to be done, the synechia should be divided. It should also be divided even after the adhesion has been present for years, but the longer it has been there the firmer will it become.

Treatment.—These adhesions are by no means easy to divide: one of the best ways for those which are not too broad is to use the twin knives devised by Lang. They consist of a sharp-pointed knife and a blunt-pointed one of exactly the same size, though if the latter is slightly sickle-shaped it is of advantage.

The operation depends for its success on not losing the

aqueous. The sharp-pointed knife is entered obliquely at the corneo-scleral junction, or a trifle outside it. As soon as it appears in the anterior chamber it is withdrawn and the blunt-pointed knife is entered at the same wound. As these two instruments are the same size the stem blocks the opening and retains the aqueous. The blade is then passed behind the synechia, and sweeping the handle in a horizontal plane the sharp edge is pressed against the synechia, which it should divide. The moment this is done the iris falls away from the cornea and the knife is immediately withdrawn. If the operation is successfully done no aqueous has been lost, but it sometimes happens that it does escape if a very wide synechia is attempted. Should this occur, and should the lens be clear, the knife must be withdrawn for fear of injuring it. If the lens has been removed the synechia may still be divided in spite of there being no anterior chamber. It often happens that two or three attempts have to be made before the whole of a wide adhesion is divided.

Another method which is very successful for a broad adhesion is to pass a narrow Graefe knife behind it, making a puncture and counter-puncture. Then a section is made as though for an iridectomy or extraction. The section is not to be completed, but as soon as ever the adhesion is divided the knife is withdrawn. By this method the aqueous is of necessity lost. Should a small adhesion be left it may be divided subsequently with the twin knives.

Wounds of the Ciliary Body are even more troublesome than those of the iris, and a cyclitis leading to degeneration of the eyeball is very apt to result. These injuries are liable to produce sympathetic ophthalmitis. Should any portion of the ciliary body be prolapsed it must be excised.

Injuries of the Choroid.—These may be produced by wounds and foreign bodies, and but little can be done for them besides assisting the external wound to heal. Some intraocular hæmorrhage is sure to occur. Should the

foreign body be still in the globe it must be localized with the X-rays and removed.

Rupture of the Choroid due to a Blow.—A blow with a fist or a blunt object may produce a crescentic-shaped rupture of the choroid, usually across the macular

FIG. 50.—Rupture of choroid.

region, but sometimes away from it. This causes intra-ocular hæmorrhage. It all depends upon the position of the rupture as to what vision remains. If the macula be involved it may cause the most serious loss of sight. The hæmorrhage may be sufficiently extensive to produce detachment of the retina, and this will probably lead to blindness of the eye. If a really large vessel be ruptured the whole of the choroid may be stripped off the sclerotic, and the eye become totally disorganized and very painful.

Treatment.—After such an accident the patient should

be kept quite quiet in bed and the eye must not be used. This is of the greatest consequence, as fresh hæmorrhage or inflammatory exudation may be excited and still greater damage may be done. Atropine must be used to keep the pupil dilated, and it is as well to keep both eyes bandaged, so as to ensure the greatest amount of rest possible, for several days.

New Growths of the Uveal Tract.—The growths of the uveal tract are either benign or malignant.

Growths of the Iris.—The benign growths of the iris are usually *cysts*, and the majority are implantation cysts due to growing epithelium being carried in and lodged on the iris or in the anterior chamber as the result of a penetrating wound. Their size varies from the smallest objects to something large enough to almost fill the anterior chamber.

Treatment.—They must be removed by operation, as they not only produce irritation of the eye, but will probably cause blindness from secondary glaucoma or degeneration of the eyeball.

Tubercle of the Iris may be single or multiple, and usually involves the ciliary body. If it spreads it destroys the eye and may lead to perforation. It is seldom primary, and more often occurs in a late stage of general tuberculosis. If necessary the eye must be excised.

Malignant Growths of the Iris.—These are usually sarcomata and are not very common. They are nearly always of the melanotic variety and are very liable to produce metastasis.

Treatment.—Excision of the eyeball is imperative. A very small growth may be excised by iridectomy, but if it is really a sarcoma the eyeball should be enucleated without delay.

Growths of the Ciliary Body are almost always malignant, and usually they are melanotic sarcomata; occasionally pigment is almost absent, and then they are termed leuco-sarcomata. The growth may commence in

the ciliary body or it may invade this structure from the choroid or iris, and may first become visible by bulging of the sclera, or it may appear in the anterior chamber.

Treatment.—The earlier the eye is excised the better will be the chance of saving the patient's life, and the less will be the risk of metastatic growths in the liver and elsewhere.

Growths of the Choroid are nearly always sarcomata, and commence either in the choroid or else involve it by spreading backwards from the ciliary body. They are usually melanotic, but sometimes they are almost devoid of pigment, and are always mixed round and spindle cell growths. They may commence at any part of the choroid, and are sometimes seen far back and sometimes close up to the ciliary body.

Symptoms.—Usually the first sign of mischief is some failure of vision. On ophthalmoscopic examination a detachment of the retina is apparent. It is seldom possible to actually see the growth, and the extent of the detachment gives but little information as to its size. A small growth acts on the retina much like a walnut might if placed beneath a table-cloth, a great deal more of it would be raised than the actual part in contact with the object producing the elevation. This sub-retinal space becomes filled with albuminous fluid. Should the growth be situated close to the macula the vision will be profoundly affected; if placed in the peripheral part of the choroid a large detachment may be present without the patient knowing much about it. It is possible for a small detachment to exist for a long time without producing much defect of vision, but suddenly it becomes much larger, and this may be the first time the patient has noticed anything the matter with the sight. Ophthalmoscopically the detachment occurring with a neoplasm has usually a rather solid look, and the retina is seldom seen to wave about. Often the venæ vorticosæ are enlarged, and then large vessels are seen leaving the eyeball and running across the outer surface of the sclera. It is always well to carefully examine the situation

where vessels leave the eyeball. Sometimes small black patches are seen here which really are portions of the growth. If a solid growth occupies a large portion of the interior of the eyeball it might well be expected that the intraocular tension would be increased, and it sometimes is. However, it is of no use to wait until the tension rises before diagnosing a sarcoma, because in many cases it is never raised at all, and valuable time may thus be lost. It is a curious fact that growths affecting the choroid only are far more apt to produce increased tension than growths involving the ciliary body. The increase of tension has scarcely anything to do with the size of the tumour, but is due, as it always is, to closure of the angle of the anterior chamber. A growth far back is much more likely to produce a shallow anterior chamber than one involving the ciliary body, and so we find a fair number of choroidal sarcomata with plus tension in the eye; we find a good many with no increase at all, but very rarely do we find minus tension. If the growth involves the ciliary body quite half of them have normal tension, a few plus and a large number minus. If these facts are realized it will be seen that the tension is not of great diagnostic importance. If it confirms other signs so much the better; if it does not do so no special stress should be laid upon it. It is well known how seldom a simple detachment of the retina comes on in any but a myopic eye, for it is the myopes who are so liable to degenerative changes in the vitreous, and these greatly favour detachment. If, therefore, a detachment is seen in an emmetropic or a hypermetropic eye with a healthy vitreous, it is a very strong point in favour of a growth being the cause of it. The detachment here will look solid and very different from the myopic detachment which is usually floating and waving about in the fluid vitreous whenever the eyeball moves. Transillumination of the globe is sometimes useful, but it may be deceptive. Taken as a whole there is nothing much more difficult in ophthalmology than the accurately deter-

mining whether a suspicious case really does contain a growth or not. Experience and careful attention to detail are the only things which avail.

If a growth be left it eventually perforates the globe and becomes extraocular, when it will grow with astonishing rapidity. Should this occur it will make its appearance through one of the places where vessels and nerves enter and leave the eyeball; either where the long or short ciliary vessels perforate or where one of the venæ vorticosæ leave the sclerotic. Consequently the growth may come through close to the optic nerve, and if it does its presence may be entirely unsuspected until the eye is being excised, and then a mass may be found to be present in the orbit. If it comes through near the cornea or the equator of the globe it is easily seen.

Carcinoma of the Choroid differs from sarcoma in being a secondary or metastatic deposit and not a primary one. It occurs as a thin, flat growth spreading along the choroid. Most recorded cases have been secondary to carcinoma of the breast, and sometimes of the stomach. It only appears late in the disease and when it is widely diffused; it is frequently missed owing to the fact that the patient is probably in a dying condition, and but little notice is taken either by the patient or by the friends of some deterioration of vision. If it were looked for it would be found to be far less rare than is generally supposed to be the case. It is impossible to distinguish one growth from the other ophthalmoscopically, but the history and condition of the patient will usually settle the question as to whether there is a primary sarcoma or a secondary carcinoma in the eyeball.

Treatment.—In all cases of primary intraocular growths excision of the eyeball containing it must be done at the earliest possible moment, or the chances of saving the patient's life will be poor indeed. It is impossible to say with certainty whether the eye has been excised soon enough or not. Even if there be no sign of the growth

outside the globe it is no proof that cells have not already been carried away in the blood stream, and are perhaps proliferating in the liver or elsewhere. In excising these eyes the optic nerve should be cut far back, so as to get as far from the growth as possible. If the growth has come through the sclerotic the orbit should be exenterated. It is obviously useless to excise an eye for a metastatic carcinoma, as by the time the eye is affected there will probably be hundreds of other growths scattered throughout the body.

FIG. 51—Congenita coloboma of the iris.

Detachment of the Choroid, except as the result of a large subchoroidal hæmorrhage, is extremely rare, and it is very difficult to distinguish it from detachment of the retina. It usually assumes the form of three or four large balloon-shaped bulgings, for at certain parts the choroid is held in contact with the sclerotic by vessels and nerves. It sometimes occurs weeks after a perfectly successful extraction of cataract. Ophthalmoscopically it has all the appearance of a detachment of the retina, but choroidal vessels may be seen through it, thus showing that the choroid and retina must be in contact. The choroidal vessels are never seen through the retina in a case of simple retinal detachment. Treatment is useless and the eye is blind. If painful the eye should be excised.

Bony Degeneration of the Choroid may occur in old blind eyes.

Congenital Defects of the Iris and Choroid.—*Coloboma of the Iris and Choroid* may occur together or either may be present alone. The cleft in the iris is usually down-

wards, and that in the choroid occupies a similar position. It occasionally occurs in more than one member of a family. Nothing can be done to remedy it.

Albinism is congenital absence of the pigment in the body, and normally deeply pigmented structures like the iris and choroid are very obvious when they contain none. In very marked cases the irides are pink and the chorio-capillaris is visible on ophthalmoscopic examination.

Fig. 52.—Congenital coloboma of choroid.

This defect of pigment runs in families, and cases are constantly appearing among those who have a family history of the condition. Nystagmus is nearly always present and the sight is defective. It is more marked in children, for when they grow up they nearly always develop some pigment. Their complexion is extremely fair and their hair usually quite white, but this also frequently becomes darker as they get older. Owing to the fact that no pigment is present in the choroid and iris, they suffer

much from the effect of strong light, and usually go about with their eyes nearly closed. Dark glasses give some relief, and errors of refraction must be carefully corrected.

Persistent Pupillary Membrane.—Fine strands of this are often left in the pupil, and are usually very delicate. Sometimes they stretch from one side of the pupil to the other, at other times they are attached at one end to the lens capsule. They always spring from the anterior surface of the iris, and are in this way easily distinguished from posterior synechiæ due to old iritis. Their presence is of no clinical importance.

The pupil is sometimes not in the centre of the iris, and sometimes there are holes other than the one usually present, thus giving rise to secondary pupils. The former condition is termed "Corectopia," and the latter "Polycoria."

Operations on the Iris.—Iridectomy is the operation which is done on the iris far more frequently than any other. It is performed in cases when the pupil is closed, such as after a severe attack of iritis, and also in cases of glaucoma where the iris is blocking the angle of the anterior chamber. If the pupil becomes closed through being drawn up, as sometimes occurs after a wound, iridectomy may be performed for the purpose of making an artificial pupil, and thus allowing more light to enter the eye. It is sometimes of value if the centre of the cornea is occupied by a dense nebula while the periphery is clear, and thus the artificial pupil is put opposite the clear cornea.

Should the eye be quite quiet and free from injection, a local anæsthetic such as cocaine is all that is required; for, although the iris is never rendered quite insensitive by its use, yet the pain caused by dragging on it is not so severe but that it can quite well be borne by the average patient. If, however, the eye is injected as in acute glaucoma, cocaine is never satisfactory, and a general anæsthetic is preferable, for it is very necessary for the patient to keep still and not roll his eye about.

The instruments required are a spring speculum, a pair of fixation forceps, a knife or a keratome, a pair of iris forceps and scissors, as well as an iris repositor.

For the incision some surgeons prefer a narrow Graefe knife, while others like a keratome.

The keratome makes a neat incision, but it can only be used with safety if the anterior chamber be fairly deep. If

Fig. 53.—Keratome.

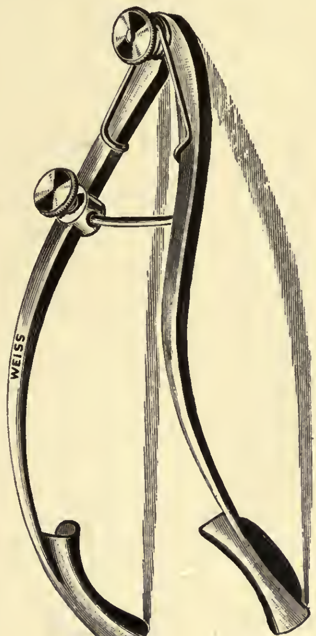


Fig. 54.—Speculum.

the anterior chamber be shallow and a peripheral iridectomy is required, such as in a case of glaucoma, the Graefe knife is far easier and safer to use, while the incision can be made of any required length, whereas a keratome always makes a smaller incision than it appears to be doing, and if the patient rolls his eye up or moves with a keratome in it, it is far more likely to injure the lens than is the knife.

The keratome has, perhaps, one advantage, and that is, it can be used with the right hand for either the right or left eye, whereas the knife must be used with the left hand for

Fig. 55.—Iris forceps. Fig. 56.—Graefe knife. Fig. 57.—Fixation forceps.

the patient's left eye if the surgeon stands in the usual position at the head of the table. If he is not ambidextrous he has to stand on the left-hand side of the patient, and cut upwards and away from himself if he wishes to use his right

hand. Should the operation be done for a blocked pupil or for optical purposes, it is sufficient for the iris to be drawn out and cut off with one snip of the scissors. If it is done for glaucoma it must be removed very peripherally, as described under the treatment for that disease, after which the cut edges of the iris must be very carefully replaced or they may remain caught in the wound.

The student will learn far more by watching a surgeon do a few operations of this kind than by reading a written description of the way to do it, consequently the details are not here described.

CHAPTER VIII

DISEASES OF THE LENS

The criterion of health of the lens is its transparency. Should its nutrition be interfered with it becomes opaque and cataractous. There are many varieties of cataracts: some are complete—that is, the lens is completely opaque—while others are incomplete or partial. The disease may be said to affect the extremes of life. Some varieties are congenital or appear in childhood, while others are senile and occur only after middle life and generally in old age.

Senile Cataract.—This is by far the most common variety. It occurs in old people, and is very rarely seen before the age of forty-five or fifty. In the early stages opacities are generally first detected in the cortex at the periphery, and so common are they that few people above sixty years of age are altogether free from them. They are best seen with a plane mirror of the ophthalmoscope, while the patient is directed to look up and down and from side to side. They are usually quite easy to be seen without the use of a mydriatic, and what is very important to bear in mind is the fact that when situated in this position they do not interfere with vision and they may not spread. Others show the opacity first in the nucleus of the lens, and in this situation it soon interferes with vision, and usually such patients complain of failure of sight, which they never do if the striæ are situated only in the periphery. Any of these opacities may spread with a greater or less degree of rapidity, or they may remain practically stationary, but the tendency is for them to increase, and for the sight to be more or less affected. Con-

sidering the fact that an opacity which scarcely blurs the vision in an elderly but healthy individual may never get worse, care should be exercised by the surgeon in not alarming the patient unnecessarily by stating that he has a cataract, when it may never get bad enough to interfere with his sight: often the knowledge causes great mental anxiety and all to no purpose. It is generally quite time enough to tell a patient he has cataract when it is sufficiently bad to cause some obstruction in vision which he notices, and which glasses are incapable of remedying.

As the disease progresses so the sight becomes worse and worse, until at last it gets so bad that the patient is able only to distinguish light from darkness. An eye which is otherwise healthy except for the cataract never gets its sight diminished beyond this stage, and should it be found that the eye cannot perceive light, it invariably means that there is some other disease present, such as detachment of the retina, choroiditis, or optic-nerve atrophy. Another important point to investigate is the projection of light. Should the eye have a cataract so dense that no view of the fundus can be obtained, it is always possible for the patient to be able to say from which direction a light is coming. The way to ascertain this is to place the patient in a dark room with an ophthalmoscope lamp behind him. A mirror is taken and a dim light is thrown into one eye, the other being carefully closed. The beam is then projected into the eye from various positions, and the patient is asked to point to the source of the light. If he does this accurately in every position it is a proof that there is nothing very wrong with the fundus; but if the light is always said to come from the same direction, and in some positions it is not seen at all, then it is sure proof that there is something other than the cataract which is causing the trouble; and it is more than likely that no improvement of the vision will take place even if the cataract be removed. It is most important to ascertain this in order to avoid disappoint-

ment to the patient and surgeon. It is very annoying to do an operation which may be perfectly successful from a surgical standpoint, and to find afterwards that there is extensive choroiditis, and that the eye is as blind as it was before the cataract was removed. If a case of early cataract is seen it is always well to examine the fundus, and to dilate the pupil if necessary, so that it may be seen before the lens becomes so opaque as to render this impossible. Often small patches of central choroiditis which may greatly reduce the vision are seen in this way which would not be apparent by aid of the projection alone. Another good way is to light two wax matches and hold them near together. An eye with a cataract only will be able to distinguish the two flames when they are very close together, but one with choroiditis or any other fundus lesion will be unable to distinguish the separate flames until they are placed wide apart. Senile cataracts vary enormously in density and in appearance. Some are quite white and opaque and can readily be seen obstructing the pupil. Others are very much darker, and cannot be seen at all without an ophthalmoscope mirror or the oblique illumination. Sometimes the lens is almost uniformly dense, at other times the denser nucleus is surrounded by soft cortex. If the cataract has been present for a long time it assumes the form known as Morgagnian cataract. In this condition the cortex of the lens breaks down and becomes fluid, while the hard nucleus is more or less free inside it. This is a degenerative change, and the lens ought to be removed before this occurs.

In order to understand the exact condition present, the anatomy and development of the lens must be borne in mind. The lens is developed from a portion of the epiblast which is cut off and surrounded by a capsule. It is, of course, an epithelial tissue, and, like all epithelial structures, it proliferates and grows all through life. Owing, however, to the fact that it is in an enclosed space it is obvious that it must either get larger or else more dense as

it continues to grow, for there is nowhere for the shed epithelial cells to go, they cannot fall off like they do from the skin or mucous membranes. The lens both grows in size and becomes much denser as time goes on. This explains the fact that in a child, the lens, will readily absorb if it is wounded, but it takes months and years for much absorption to go on if the lens of any adult be wounded, and the older the patient is the less chance there is of its disappearing. When first the lens is commencing to get opaque it is apt to swell, and we frequently find a very shallow anterior chamber in a patient who has a developing cataract. This swelling is a source of danger to an eye which is ready to develop glaucoma, for it may just be sufficient to shut up the angle of the anterior chamber and cause a rise of tension. It is well known how very prevalent cataract is in hot countries like India and Egypt, and it is likewise common in arctic regions, where the cause is much the same, viz. intense glare from the sun. People following certain trades are more prone to it than others, viz. glass-blowers, men engaged in smelting works, stokers, etc., for exactly the same reason.

Symptoms.—The essential feature about cataract is the failure of vision which it occasions without any pain or discomfort in the eye. It has been mentioned above that the lens is very apt to swell. When this takes place its refractive power increases, so that if it is still fairly clear such people may suddenly discover that they are able to read without their glasses, a thing they could not possibly have done for many years past. At the same time the distant vision may be somewhat less acute, owing to the eye becoming myopic. This, however, is only temporary, and soon the sight for all purposes begins to fail again and become worse than it was before. Should the opacity be fairly central, with clear cortex, the vision is much better in dull lights than in bright sunshine, owing to the fact that the pupil contracts in the strong light. If the opacity is peripheral it may be very dense and scarcely

affect the sight at all, but sooner or later the central part becomes opaque as well, and then the eye quickly loses its sight.

It is never possible to predict with certainty how long a cataract will take to become ripe. Some will undergo more changes in a month than others will in a year or more. It is better to wait until the lens is quite opaque before attempting to remove it, but if both eyes are equally affected, and although the cataracts are neither of them ripe, yet it may become so serious a matter to the patient, and so important for him to get his sight back, that the surgeon is induced to extract the lens long before he would choose to operate if the patient had one eye to work with. These cases usually do well, but it must be admitted that the risk is greater, as the incomplete cataract may be so sticky that much of the cortex is left behind, and this takes weeks and weeks to absorb; while, should iritis in any inflammatory condition supervene, the lens matter will get infiltrated and so dense that it may never absorb at all. Still the risk is often worth running in order to save the patient months or years of blindness. Should the first eye do well the second can be left until it is ready.

Although it is far easier to examine a lens with a dilated pupil, yet no mydriatic should be used without carefully examining the depth of the anterior chamber and ascertaining the tension of the eye, otherwise an acute glaucoma may be the result.

Artificial Ripening.—In order to hasten the time when a cataract will be ready for operation Förster's method is adopted by some surgeons. A preliminary iridectomy is done, and when the anterior chamber is empty and the lens and cornea are in contact a squint hook is taken, and with its angle the lens is gently yet firmly stroked through the cornea; this disturbs the lens fibres and may even rupture the capsule, and in the course of a few weeks the lens may be quite opaque. It is rather a dangerous

procedure, and most surgeons would prefer to extract the immature lens. Should the cataract in one eye cause a considerable degree of blindness while the other eye is good, the surgeon frequently has to decide as to whether it is wise to extract the opaque lens. There are many reasons against doing it, but occasionally it may be advisable. It must not be forgotten that an eye in its normal condition will never work with one which has had its lens removed. This is a serious matter in cases of young people who have had traumatic cataract, for binocular vision with fusion is never again possible. Equally impossible is it for an elderly person to get fusion after the operation. It is obvious, therefore, that the patient will not derive much assistance from the operated eye, no matter how perfect it may be, as he will prefer still to use the unoperated one. Then there is the fact that all operations have certain risks; the eye may not do well, even suppuration or sympathetic ophthalmitis may ensue, and under the best circumstances almost the only benefit such a patient derives is that his field of vision is enlarged. He may have perfect normal acuteness of vision with his correcting lens, but as soon as he wears it he gets diplopia, because of the different size the images appear in each eye, and they can never or scarcely ever be combined. The result is, that these people get along far better using the unoperated eye alone than they do when the glasses are worn and both eyes see, and thus the surgeon gets very little credit for what he has done. On the other hand, it is not advisable to allow a cataract to remain for years and years, for it will then pass into the Morgagnian stage, and may lead to degeneration and further changes in the eye. If one cataract is complete and the other lens is becoming opaque, then undoubtedly the complete one ought to be extracted so as to get a good seeing eye by the time the other becomes blind. The enlarged field obtained by having two seeing eyes is of importance to men like engineers, who

are in the midst of moving machinery, as a serious accident may happen from them getting entangled with moving wheels, through failing to see them on the blind side. This fact does not often come into consideration with people who suffer from senile cataract, though it frequently does in cases of traumatic cataract.

Other Forms of Acquired Cataract.—Many abnormal conditions of the system produce cataract; the most frequent causes are Bright's disease and diabetes. These diseases interfere with the nutrition of the lens, and so it becomes opaque. This form of cataract differs in no important respect from the senile variety.

Black Cataracts.—Sometimes the lens, instead of being grey or white as usual, gets quite black, and it is thus difficult to see. Its colour is supposed to be due to blood pigment. A black cataract is rather suggestive of an unhealthy eye, and the prognosis given should be guarded.

Congenital Cataracts.—These may be complete and due to defective development of the eye, and are often associated with some other congenital peculiarity, such as persistent hyaloid artery or a persistence of a fibro-vascular membrane behind the lens. Should an operation be decided upon in order to remove such a cataract, a very guarded prognosis should be given, as it is impossible to be certain what the state of things is in the posterior part of the eyeball.

Lamellar, or Zonular, Cataract is usually congenital, but it may form, or at least may get worse, during childhood or later. Both eyes are nearly always affected. The opacity in these cases is arranged in laminæ; thus the centre of the lens may be clear, then follows an opaque layer of lens matter, next comes some clear lens, and then perhaps another opaque layer (Fig. 58). Round the equator of the lens small forked opacities are frequently seen, sometimes termed "riders." The amount of opacity varies enormously. Sometimes the lens may be so dense that the child is practically blind. At other times the

opacities are so minute that they make no difference to the sight, but it is important to recognize their nature, as otherwise they may be mistaken for a progressive cataract if seen in a grown-up person, when as a matter of fact they may always have been present. As a rule the cases are not progressive, at any rate after infancy, though occasionally they do get more dense. There is usually a rather broad layer of clear lens matter surrounding the central opacities, which do not extend to the equator, and this clear layer at most has a few "riders" on it. Thus, if the pupil be dilated a good view of the fundus may often be obtained, when not a trace of it can be seen through the opaque layers with a contracted pupil.

Fig. 58. Lamellar cataract (Lawson).

Associated with lamellar cataract are two curious conditions. There is nearly always a history of convulsions and fits in infancy, and the enamel of the teeth is very defective. It is laid down in an irregular manner, and many of the teeth, particularly the incisors, have a honey-combed appearance, due to this cause: the result is that they quickly decay. It will be remembered that the lens, the brain and the enamel of the teeth are all derived from the epiblast, and it is probable that during development something happened which interfered with the nutrition of the whole of this layer of the blastoderm. Although many of the subjects of lamellar cataract are perfectly sharp and intelligent, yet some of them are peculiar. They are scarcely ever able to direct their eyes and fix them on any particular object, but they roll them about in an aimless fashion, and often they are mentally deficient or are subject to epilepsy and other neuroses. These cataracts are quite soft in children and may be needled, and if necessary the opaque matter evacuated a few days later if it should be causing tension or irritation of the eye.

Anterior Polar Cataracts are usually the result of a

perforated corneal ulcer. The lens remains in contact with it for a time, and subsequently develops an opacity at this spot. Sometimes they are congenital and occur with no visible corneal lesion. They are caused by a proliferation of cells beneath the lens capsule.

Posterior Polar Cataract.—This is an opacity at the posterior pole of the lens, and is usually secondary to some other disease, such as choroiditis, retinitis pigmentosa, high myopia, or vitreous disease. It often progresses and leads to complete opacity of the lens. This form of cataract should always be looked upon with suspicion.

Traumatic Cataracts are the result of injury, generally a perforating wound, but the so-called concussion cataract is essentially a traumatic one, though the lens has never been actually touched with a foreign body. It is quite possible to rupture the lens capsule by a blow from a blunt object which never actually produced a wound of the globe. Within a very few hours of the injury an opacity is seen spreading through the lens, and should the rupture in the lens capsule be extensive, and the patient young, the lens fibres will break up in the course of a few days and come forward into the anterior chamber. The aqueous disintegrates the lens more and more, and finally absorbs it altogether. After this nothing but the capsule remains. This sequence of events occurs only under the most favourable circumstances. Frequently the foreign body which caused the accident remains inside the eye and has to be removed, while often it may carry infective matter into the globe and lead to iridocyclitis or suppuration of the whole eyeball. If the hyaloid membrane is ruptured and the vitreous mixes with the lens matter it much retards its absorption. It occasionally happens that a wound instead of leading to the lens breaking up and absorbing, simply renders it opaque, and still more rarely the lens may be injured and the opacity remain strictly localized to the spot touched by the foreign body.

In any case of traumatic cataract whenever there is a

possibility of there being a foreign body within the eyeball, an X-ray photograph should be taken, so as to make quite certain about it. Should it be there, the foreign body must be got out, even though the eye be sacrificed in order to do it, as it is usually too dangerous to leave it for fear of its causing sympathetic ophthalmitis. It is of very little use to try and search for a foreign body in an eye unless the surgeon not only knows it is there, but knows also its exact position. Atropine must be used from the first, and must be continued so long as any irritation remains and there is any soft lens matter to be absorbed. It is frequently necessary to break the lens up by needling or to remove it by a linear extraction with curette evacuation; and, if necessary, washing out the broken-up lens matter with a stream of sterilized saline solution.

Secondary Cataracts.—This term is used somewhat loosely. It is applied to a dense membrane which occludes the pupil and covers the lens, and consists of organized inflammatory exudation, the result of a severe plastic iridocyclitis. It is also used to indicate those cases in which the lens has been removed, but where the capsule has been left behind. This capsule is generally clear at first, and does not interfere with the sight to any appreciable extent; but as the posterior layer is intact and contains living epithelial cells, it frequently happens that these cells grow and produce an irregular thickening and wrinkling of the capsule, and this interferes considerably with sight. It is nearly always possible to tear a hole through the capsule which will then gape, and leave a clear space through which good sight is obtained. This secondary needling has to be done sooner or later in the vast majority of cases after removal of the lens, unless the more serious operation is undertaken of removing the lens in its capsule, as advocated by some surgeons, especially by Colonel Henry Smith of the Indian Medical Service, who has operated by this method on thousands of cases.

Operations for the Removal of Cataracts.—The

greatest ingenuity has been exercised in devising operations for the removal of cataracts, and they may be divided roughly into two groups. Soft cataracts—that is, cataracts occurring in young people—can usually be got rid of by opening up the capsule with a needle, and then either letting the aqueous absorb the opaque lens matter, or else by evacuating it through a small incision made with a broad needle (Fig. 59) after it is well broken up. Hard cataracts—that is, those occurring in adult life—are too dense to allow of their being treated in this way, so that it is necessary to remove them entirely. The operations are either : (1) In young people, needling with or without subsequent evacuation; (2) in older people, extraction of the lens with or without the capsule.

FULL SIZE

Fig. 59. Broad needle.

Needling of Soft Cataracts.—This operation may be undertaken in people up to about twenty years of age, but if it is done in those older than this the lens is so hard, and takes so long to absorb, that most people prefer to extract it. Before undertaking any eye operation the greatest care must be taken to ensure perfect cleanliness of the lids and conjunctival sac, and on no account is the eye to be operated upon if there is a trace of obstruction or regurgitation from the lacrimal sac, the eye is certain to be lost from suppuration if this be done.

It is well to keep the eye tied up with a pad for twelve hours before an operation, so that it may be possible to see whether there is any stickiness or discharge along the lid margins; if there is the operation should be deferred until the lids are treated and rendered clean. It is a good plan also to have a culture tube inoculated from the conjunctival sac, so that if dangerous organisms are present the operation can be deferred. The pupil is then fully dilated with atropine, and after cocaine 2% is applied the conjunctival sac and the lids are thoroughly

washed with sterilized water, boracic lotion or perchloride of mercury lotion of about 1/8000. A speculum is inserted to keep the lids open, and the conjunctiva gently grasped with fixation forceps (see Figs. 54 and 57). The needle is then taken and inserted just outside the clear part of the cornea in what appears to be the commencement of the sclerotic. A vertical slit is then made in the lens capsule from top to bottom, and then a similar horizontal cut is made, but care should be taken not to penetrate deeply into the lens, and on no account is the needle to be pushed so far through the lens that the vitreous is wounded, as this would ensure trouble, if not disaster, for lens matter is very difficult of absorption when mixed with vitreous.

Fig. 60. Discission needle.

The needle is then withdrawn, and if the operation has been done neatly, and the needle has been entered obliquely, no escape of aqueous should take place. If the needle is inserted through the cornea there are many disadvantages. Aqueous is almost certain to escape when it is withdrawn, and

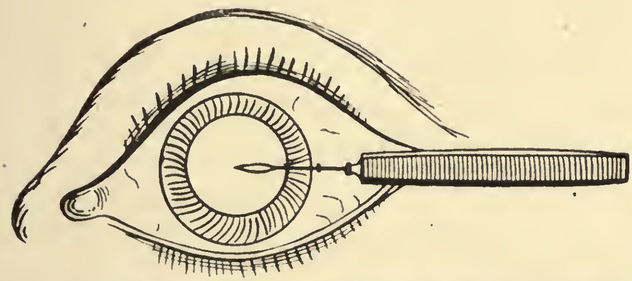


Fig. 61.—Showing position of insertion of the needle in discission of lens capsule or in needling of lamellar cataract.

it is quite possible that a tag of capsule may be washed out through the puncture, or may follow the needle, and if it does, suppuration of the eyeball is more than

likely to follow. As it is quite transparent and invisible at the time, it is usually not seen until infection has taken place. All this trouble is avoided if the puncture be made obliquely just outside the corneal margin. The speculum is removed and the eye is covered with a pad. Atropine drops, 1 %, must be used vigorously, for weeks perhaps, until the eye is quite quiet and all the lens matter is absorbed. In many cases this will happen without any further trouble, especially if the capsule has been well opened, as recommended. After this the only thing required will be the final needling of the posterior capsule. Sometimes, however, the lens matter swells up so rapidly that it blocks up the angle of the anterior chamber and causes tension with sickness just like acute glaucoma. Under no conceivable circumstances must eserine be used. Atropine must be used more than ever, for if once the pupil became contracted it would probably never dilate again, the tension would be increased instead of diminished, and the pupil would be entirely blocked. The cause of the tension here is the swollen lens, and the obvious thing is to get rid of it. There are many ways of doing this, but perhaps the best way is to make a linear incision obliquely through the cornea at the junction of the upper and middle thirds with a broad needle or a keratome, and then ease out the lens matter with a curette (see Figs. 53, 59 and 65).

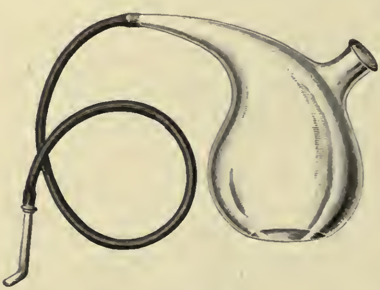


FIG. 62.

The lens matter may be washed out by means of an undine, to which a flexible tube is attached having a silver nozzle at the other end (see Fig. 62). The undine contains warm sterilized normal saline solution which should have been boiled in it. It is held up to a sufficient height by an

assistant while the surgeon carefully introduces the nozzle into the anterior chamber through the valve-like corneal incision. The fluid is then allowed to freely flow into the eye, and on its return it washes out the loose lens matter, which is sometimes far more difficult to get away than would be expected. When all the lens matter has been removed care should be taken to fill up the anterior chamber with fluid, so as to avoid the risk of getting capsule adherent to the wound. If the incision is made in an oblique manner through the cornea the edges fit so well together that there is no difficulty in doing this. On no account must any mercury be allowed to get inside the anterior chamber as it will cause the cornea to become opaque.

A suction syringe is a dangerous instrument to use; and the nasty practice of applying suction with the mouth at the one end of a rubber tube, attached to a silver nozzle which is in the anterior chamber, as used to be done, is a violation of all possible rules of aseptic surgery, and ought never to be practised. Should an anterior synechia of iris or capsule form at the wound it may easily be divided a few days later. Some surgeons prefer to make their incision for evacuating the lens matter at the corneo-scleral junction, but this is almost certain to lead to an adhesion of the iris to the wound in a position in which it cannot be divided; it may also lead to a prolapse of iris which will have to be cut off, and thus a distorted pupil is the result. Atropine should be continued until the eye is quite quiet.

Linear Extraction as described above may be used to remove soft cataracts which are quite opaque and which do not require previous needling. Some surgeons treat incomplete extracts in this way without previously needling them. It is a specially useful method when dealing with traumatic cataracts, concussion cataracts, and cataracts which have arisen secondary to cyclitis. Sometimes these latter are almost fluid, and come away with readiness when the capsule is opened.

Extraction of Cataract.—This is the most technical operation in the whole of ophthalmic surgery. As much or more ingenuity has been expended upon it than over any other operation in the whole domain of surgery, and even now opinions are divided as to which is the best method, while the technique varies with almost every surgeon who operates.

There are four main groups of operations practised at the present time:—

(1) Simple extraction of the lens from within its capsule without iridectomy.

(2) Combined iridectomy and extraction of lens from within its capsule.

(3) Extraction of the lens from within its capsule after a preliminary iridectomy done several weeks before.

(4) Extraction of the lens *in* its capsule with or without an iridectomy.

It is impossible to even mention the various modifications of these types of operation which are practised by different surgeons. No one can learn how to operate for cataract from reading a description, so that before the student attempts to do it he should carefully watch a surgeon of experience, and should if possible obtain the assistance of one to help him at his early cases. Eye operations are so different from most general surgical operations where there is plenty of room, and where the exact length and the exact situation of the incision are matters of indifference, and should the knife be blunt a little extra pressure will take it through the tissues. In an eye the incisions have to be made in situations in which there may not be half a millimetre between safety and destruction, and an incision a millimetre too short or too long may mean the loss of half the vitreous or the entire eye; while a blunt knife which cannot possibly be changed after it is once within the eye may mean absolute disaster if pressure has to be used in order to make it cut its way

out. Instruments nothing short of perfect must be employed for an intraocular operation. Unless the light also is of the best the gravest risk is run.

Good daylight is not bad, but electric light in an otherwise darkened room is perhaps better. A 16 or at the

Fig. 63.—Operating lamp by Curry and Paxton.

most a 32 C.-P. lamp is quite strong enough, and its beams should be focused on the eye by means of a biconvex lens held by an assistant, or a hand-lamp should be used. A general anæsthetic is never necessary for cataract extraction in any one who has a reasonable amount of self-control, but it is far better to give chloroform than to

have a restless patient who is liable to move and squeeze the eye during the operation. It is not necessary or advisable to dilate the pupil with atropine previous to extraction, like it is with needling.

The patient is laid flat on his back on the table, or on a small bedstead which has no head to it. The eyelashes are cut short and the conjunctival sac well washed out with sterilized saline solution. The surgeon stands above the head of the patient and inserts the speculum (see Fig. 54, p. 149). If it is the right eye upon which he is to operate he takes the Graefe knife in his own right hand (Fig. 56, p. 150) and his fixation forceps in his left, and the incision is made with his right hand (Fig. 57, p. 150). If the left eye is to be operated upon he takes the knife in his left hand and steadies the eye with the forceps held in his right. Should he not have sufficient confidence in making the incision left-handed he can adopt two plans: one is to have a Graefe knife with a bent handle thus—

Fig. 64.

so that it can be used with the right hand without the patient's nose getting in the way; or else he can stand below and on the left side of the patient and enter his knife with the right hand and cut upwards and away from himself. The majority of surgeons, however, use either the right or left hand as may be required, and always stand above the patient.

The incision requires careful planing, and in size should include about four-fifths of the upper semicircle of the cornea. The point of the knife should be inserted close to the corneo-scleral junction but a trifle behind it; it should then be made to enter the anterior chamber and be passed across it to a position similar to that of the

point of entry on the other side; the counter-puncture thus made should exactly correspond to the puncture. Unless the beginner is very careful he is certain to make his counter-puncture much further back than he intends, and this should be guarded against; it is better to come out a little too far forwards than too far backwards. By means of a slow sawing motion, and with scarcely any pressure at all, the knife is made to cut itself out, and the incision is thus made slightly behind the apparent corneo-scleral junction, and a nice conjunctival flap is formed, which may be reflected on to the cornea during the operation, but which much aids the closure of the wound afterwards. While passing the knife across the anterior chamber some surgeons are in the habit of picking up and opening the lens capsule with its point, but unless great care is exercised the aqueous may escape while tilting the knife, and if it does, difficulty will be experienced in making the counter-puncture. It is really safer, at any rate for a beginner, to insert the cystitome and open the capsule with this after he has finished his incision (Fig. 66). After this is done pressure at the lower part of the cornea is made with a curette (Fig. 65) and the lens should then present, and will easily force its way through the pupil, and will thus be delivered. Should there be any opaque matter left behind, this must be carefully expressed if possible, or it may be washed out with a fine stream of warm sterilized saline solution from an undine and introduced through a small silver nozzle placed in the anterior chamber (Fig. 62, p. 164). If this be done great care must be taken to prevent the patient squeezing his eyelids, otherwise the hyaloid membrane may be ruptured and vitreous

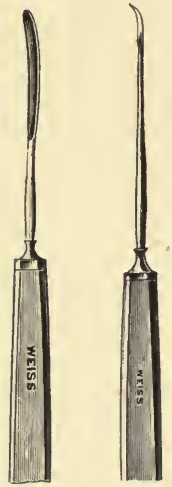


Fig. 65. Fig. 66.
Curette. Cystitome.

will escape. When all soft matter which can be got rid of is removed the iris is carefully replaced, and should the pupil be altogether uninjured and be *perfectly circular*, it may be left. Should be it oval or drawn up it is certain to prolapse within a few hours, and it is far better to do an iridectomy at once than run the risk of having to do it the next day. Many surgeons habitually do an iridectomy, and never attempt to remove a lens without having done so. Under these circumstances it is usual to do it directly after the incision, and before opening the capsule, unless this has already been done with the knife at the time when it was passing across the anterior chamber. After everything is carefully replaced and the conjunctival flap, if there be one, is spread neatly over the wound, the speculum is removed and the eye covered with a pad and bandage. Some surgeons cover both eyes for a few days, but it really does not much matter, and most people are more comfortable with one eye which can be used if necessary. Atropine should be used directly after the operation, though it is not likely to cause much dilatation of the pupil before the anterior chamber has reformed, but at any rate it does no harm, and it is the safest thing to do. The anterior chamber sometimes reforms in an hour, but in other cases not for several days; the conjunctival flap helps this greatly.

Relative Advantages of Extraction after a Preliminary Iridectomy; Extraction with Iridectomy; and Simple Extraction without Iridectomy.—Although the greatest amount of discussion has taken place at all times between those who advocate the combined operation and those who favour the simple, yet if the results of the two schools are compared there will be found very little to choose between them. Both operations give excellent results in competent hands, and naturally the surgeon will favour the one which gives him the most satisfaction. Owing to greater practice he will be more skilful in doing his usual operation than he will be in undertaking a method with which he is less

familiar. Looking at the matter from all sides, the points in favour of the simple operation are these. The patient is left with an intact pupil which will act as well as it did before the operation; this will cut off the peripheral rays and prevent to a large extent spherical and chromatic aberration. It is almost impossible for capsule to be entangled in the wound if no iridectomy be done, as the iris sweeps back any tags when it is replaced after the removal of the lens. It frequently happens in a few months or years after a successful operation, the surgeon himself may fail on a superficial examination of the eye to recognize the fact that it has ever been operated upon, and on careful examination the most that can be seen is a slightly deeper anterior chamber, perhaps a slight tremor of the iris, and possibly a faint indication of the incision. The appearance of such an eye is perfect, and no ordinary person would be able to see that an operation had ever been performed upon it. If, however, the eye did not do quite well after the operation, and iritis supervened, the chance of getting a blocked pupil would be increased, and if the pupil could not be dilated, considerable trouble might be experienced in a subsequent needling, and perhaps an iridotomy would be required.

The advantages of doing an extraction and iridectomy combined are these: it is generally rather easier to remove the lens if there be a coloboma present; and it is certainly easier to clear away soft lens matter which may be left after the lens has been delivered. There is practically no danger of having to deal with a prolapsed iris within a day or two of the extraction, as sometimes happens even with the greatest care if no iridectomy is done. The vision is practically as good after a successful operation even though there is a coloboma present, as it is after the simple operation. In these elderly people the appearance does not go for much, for if the coloboma is upwards it is usually covered with the eyelid, and cannot be seen unless it is looked for; there is, however, a greater chance

of entanglement of capsule in the wound than in the simple operation, and it is a very serious matter when it occurs.

The advantages claimed for preliminary iridectomy are these: it is held by some that it is a far safer procedure; there is no bleeding from the cut iris at the time when it may obscure the surgeon's vision, just at the critical time when the lens is being extracted. Blood in the anterior chamber is never a desirable thing, but it is still less desirable if it becomes mixed up with soft lens matter. One is able to judge of the probable behaviour of a patient at the time of the extraction, by the observations made at the first operation, where restlessness and loss of self-control are far less serious than they would be if the lens were being removed. On the other hand, it involves two operations, which is a serious consideration in elderly people. Prolapse of the iris after extraction is as unlikely to occur as it is after the combined operation, but here again capsule is quite as likely to get into the wound and cause subsequent trouble as it is in the ordinary combined method.

It will thus be seen that on the whole no operation can be said to be without certain advantages and certain disadvantages, and each surgeon must decide for himself which method he likes best, but let no advocate of the simple operation imagine that he will succeed in avoiding an iridectomy in every case. Unless he recognizes the cases in which the iris will or will not stay in after extraction, and unless he does the iridectomy in the latter class at once, he is certain to have to do a secondary operation at a time when it is all important to keep the patient quiet. Let him never promise to do an extraction without iridectomy, for circumstances may arise in which it is impossible to avoid it.

Extraction of the Lens in its Capsule by Smith's Method is so seldom done in England, and is so excessively technical, that it is impossible to find room to describe it, but for those who wish to find out about it many original papers

have been published by the author, and others, which can be consulted. It is wise for no one to attempt it unless he not only knows the technique well, but has seen a surgeon of experience perform the operation. A skilled assistant who has had training in the part he has to play is essential.

If it is proved that the majority of cataracts can be safely extracted in their capsules it must be the ideal operation, for no capsule and no soft lens matter remains. If, however, the attempt has led to a serious loss of vitreous, as it is pretty certain to do in any but the most skilful hands, the chances are that a better result would have been obtained through extraction by one of the more usual methods.

A method has recently been described by Stroud Hosford of removing the lens in the capsule. After the incision and iridectomy has been performed he inserts a discission needle into the lens near its equator and rotates it (the lens) on an antero-posteror axis. In this way the zonule of Zinn is ruptured, and the lens in its capsule can be delivered in the usual manner.

CHAPTER IX

DISEASES OF THE VITREOUS

The vitreous, being an avascular structure, behaves very differently under inflammatory changes from ordinary tissues.

Muscæ Volitantes are the small opacities which are present in the healthy vitreous, and are of no pathological significance. They may be seen by any one with healthy eyes under certain conditions. If a person looks at a white sheet of paper or a cloud, or down the tube of a microscope with nothing in focus, small black bodies of irregular shape and size will be seen floating across the field. They are far too small to be visible to an observer with an ophthalmoscope. They usually become noticeable to people who are straining their eyes with a wrong correction for a refractive error, and are not noticed unless sought for if the eye is in a normal condition. Any one complaining of them should have his refraction carefully gone into, and should be advised to avoid looking for them and worrying about them.

Vitreous Opacities.—By these are meant floating opacities which are visible to the observer with an ophthalmoscope. They are always indicative of a pathological condition, and are usually the result of some inflammatory change in the ciliary body or choroid. They are frequently present when the vitreous is under some abnormal condition such as in myopia, when the eyeball is much stretched. The largest floating opacities are seen after hæmorrhage into the vitreous either as the result of injury or disease.

Fine Dust-like Opacities are almost pathognomonic

of syphilis, and occur in the secondary stage; they are diffused all through the vitreous and very seriously interfere with vision. Usually they are an accompaniment of a syphilitic uveitis.

Moderate-sized Opacities are like threads and small bodies floating about in the vitreous. These occur with slow choroidal affections, such as in myopia or as an accompaniment of choroiditis, especially in the later stages of syphilis. They may be the result of a previous intra-ocular hæmorrhage. They are often very troublesome to the patient, who constantly sees them floating about, though often the sight is so defective that no notice is taken of them.

Dense Membranes in the Vitreous cause very serious interference with sight. They may follow an intraocular hæmorrhage or some inflammatory change. These and similar changes are seen in cases of retinitis proliferans (see p. 191).

Diagnosis.—The diagnosis of floating opacities in the vitreous can be made by means of the ophthalmoscope. It is far easier to see them if a dull light be used, and a plane mirror of an ophthalmoscope with a + 10 lens behind it. The observer should use the direct method, but he places a strong + glass before the sight-hole of the ophthalmoscope in order that his vision may be focused in the vitreous and not on the retina. If too powerful a light be used many fine opacities will be missed altogether, as the light will not be sufficiently obstructed by them to interfere with its passage, and hence they are invisible. If now the patient be asked to move his eye up and down and from side to side, the floating opacities will be seen, especially when the eye comes to rest with the observer looking straight at the disc, which is, of course, out of focus. Against the pale disc fine opacities show up better than elsewhere. Large opacities, membranes and blood clots are sometimes to be seen with the oblique illumination in a dark room.

Prognosis.—Vitreous opacities are very likely to become absorbed, except the small dustlike ones; the others remain, as a rule, permanently. They always indicate an unhealthy state, and frequently the vitreous undergoes some shrinking. The space thus left becomes filled with fluid, so that the tension of the eye is not necessarily lowered. A shrinking vitreous certainly favours, if it does not actually cause, a detachment of the retina.

Treatment.—If the cause of the trouble be apparent this must be treated, and the fine opacities which occur in secondary syphilis are the most likely to disappear. Sometimes subconjunctival injections of cyanide of mercury or of a 4 % solution of sodium chloride do good, though these injections are by no means painless. Some good results from the daily rubbing in to the temples of an ointment of 10 % oleate of mercury.

Sparkling Synchysis.—This appearance is due to the presence of cholerestine and similar crystals in the vitreous. It is a degenerative change, and usually there is very defective vision. With the ophthalmoscope it presents a beautiful and striking appearance. Whenever the patient moves his eye large masses of these fine crystals are seen moving in the vitreous like golden rain. In such an eye the vitreous, instead of being of normal consistence, is shrunken, and fluid has taken its place, hence the readiness with which these opacities and crystals can be stirred up.

Foreign Bodies in the Vitreous are very serious, not only on account of the injury they may do on entering, but also because septic material may be introduced into the interior of the eye. Considerable damage may also be done by attempts made to extract them. Pieces of iron or steel fortunately form by far the greater bulk of foreign bodies which enter the eye, and as these are magnetic they can often be withdrawn by applying a magnet outside the eye. It is a curious fact that men such as road-menders who are using pickaxes, or stone-masons using chisels and

hammers, are seldom injured by pieces of stone, it is nearly always a fragment of the axe, hammer or chisel which flies. It is well to remember this, for so frequently a patient complains that a piece of stone has struck him, and if this is assumed to be the case the surgeon may consider it useless to employ the magnet, which will quite readily extract the piece of steel which may be in the eye. Of course stone may penetrate, but a foreign body should always be assumed to be magnetic until it is proved that it is not so; in this way many a foreign body has been removed which by the history appeared to be non-magnetic. Small lead shots not infrequently penetrate the eyeball, but with objects flying so fast as this it is possible that they may have traversed the whole globe and have become lodged in the orbit. Owing to the amount of intraocular hæmorrhage which these injuries cause, it is often impossible to see inside. In such cases the X-rays are invaluable, and many an eye was lost in the past on account of

FIG. 67.—Haab's giant electro-magnet.

fruitless endeavours to remove a foreign body which was not in the eye at all. Statistics have shown that if the foreign body could be seen, many eyes were saved, but if it could not be seen nearly every eye was lost, chiefly owing to the disturbance of parts caused by searching the vitreous with the point of the magnet. The giant electro-magnet, first introduced by Haab, has saved many eyes (Fig. 67). The patient should be brought up to it and the current turned on. Often the foreign body will fly out through the wound of entry, and even if it will not do this it may be drawn forwards to a position favourable for extraction. Still the X-rays should never be neglected as a means for determining not only the presence of an unseen foreign body, but also its exact position. It very often happens that a foreign body is not in the eye at all even when the nature of the injury would point to this being the case.

Patients will seldom believe that there is anything within the eye as they cannot feel it—as they think they must do if it be present.

The removal of foreign bodies from the interior of the eye is impossible without special apparatus, and much care and skill are required in order to do it.

It is never wise to leave a piece of metal in the eyeball, and it is almost an axiom that if it cannot be removed by itself it is better to remove the eye containing it. Sympathetic ophthalmitis is always possible in this condition, and it very seldom happens that an eye will retain its sight if there is anything in it; degenerative changes are almost certain to take place and lead to detachment of the retina and blindness. Should it be a piece of iron or steel siderosis will occur, and the iris and whole interior of the eye will become a rusty colour due to deposition of iron rust. Copper is most irritating and glass the most harmless of any. Eyes containing glass often remain quiet indefinitely and show no sign of irritation.

Persistent Hyaloid Artery.—It sometimes happens that the hyaloid artery, which is present and active during

part of intrauterine life, does not disappear as it normally does previous to birth. It is a branch of the central artery of the retina, and is only represented in the normal eye by a small canalis hyaloideus or canal of Stilling. It runs from the centre of the disc to the back of the lens. If a small part of it remains patent it may be seen in the vitreous with the ophthalmoscope. It is of no pathological significance, but may be accompanied by other congenital defects.

Suppuration of the Vitreous is usually the result of a wound or of a general pyæmic infection. In children it may assume a more chronic form and be mistaken for a glioma of the retina. Excision of the eye is the proper treatment for this condition. See remarks on the treatment of suppurative choroiditis on p. 133.

Cysticercus in the Vitreous.—It is very rare in the British Islands, but is not so uncommon in certain parts of Germany. The parasite is either subretinal or else it has burst into the vitreous. If subretinal it may be removed. If it has invaded the vitreous it has caused the eye to be disorganized, and the prognosis as regards sight is hopeless. Excision of the eye will probably have to be done.

CHAPTER X

DISEASES OF THE SCLEROTIC

The sclerotic, being but poorly supplied with blood-vessels, does not very frequently get inflamed, but inflammation is liable to spread to it from other structures.

There are two forms generally recognized : (1) the superficial variety, termed episcleritis; and (2) the deep affection of the whole of the sclera, the real scleritis.

The sclera frequently looks very red and inflamed, but the student must be on his guard against thinking every red eye has scleritis. It must be remembered that the conjunctiva is far more liable to inflammatory attacks than the sclerotic; and inasmuch as the conjunctiva is attached but very loosely to it, we find that the conjunctival vessels can easily be made to move about over it by a little digital pressure, whereas the inflamed vessels of the sclerotic are much deeper, much finer, and do not move; they are obviously in the sclera and not on it. In many respects the injection of an inflamed sclera resembles the deep ciliary injection of an iritis or cyclitis, but as a rule an episcleritis injection, though very marked and very deep, is confined to one particular segment of the eye, and a good deal of the circumcorneal region will be white and free from any sign of inflammation. This is never the case in iritis, for then there is a deeply injected ring all round the cornea.

Episcleritis, or Superficial Scleritis.—In this condition there is usually a patch on the sclerotic of deep injection which reaches right up to the cornea. It is often raised and sometimes looks like a very much developed

phlycten. There may be some conjunctival injection as well over it, but it nearly always happens that the affected part is sharply cut off from the unaffected portion, and although the redness may be very intense, yet the greater part of the eye is perfectly white, and there is very little sign of irritation except at the affected spot. The vessels seldom encroach on the cornea, which is practically never affected, and the pupil remains active. Although the eye may be tender to the touch, and have some lacrimation, there is seldom severe pain such as there is in iritis, nor is there keratitis punctata nor anything suggesting the presence of cyclitis. It is extremely uncommon for it to spread beyond its own limits, though it sometimes does affect both the iris and ciliary body.

FIG. 68.—Episcleritis.

Causes.—It is often difficult to find the cause, for it occurs in people who are otherwise in perfect health, and recurrences are frequent. Some people have a severe attack coming on in either eye once every year or so, others have milder attacks coming on more frequently. It is usual to ascribe it to a gouty or rheumatic tendency, and perhaps it is, but it often enough happens that the patient has had no symptoms of the one or the other. It may occur in persons who have had syphilis, but it is pretty certain that this disease has nothing whatever to do with it directly, for it is common enough in those who have never suffered from either the acquired or inherited variety, and who have never been exposed to venereal infection. It no doubt occurs as the result of some toxæmia, but at the

present time we know but little of what it is; uric acid seems to be the most likely cause.

Treatment.—These cases are very difficult to cure; and they often go on for weeks with no apparent improvement. Cold nearly always does harm, and some of these patients do not get well until they are sent to a warm climate or until the summer comes round. It is usual to give quinine and salicylates, and sometimes small doses of mercury, such as calomel gr. $\frac{1}{6}$ with a grain of quinine and gr. $\frac{1}{8}$ of extract of belladonna two or three times a day. The bowels should be kept freely open with salines, while colchicum does good in some cases. Hot bathing of the eye is always comforting, and Turkish baths do good in many cases. The teeth should be carefully attended to. If the iris or ciliary body is affected atropine must be used.

Scleritis.—This is a much more serious affection, as it is liable to lead to cyclitis and permanent damage to the sclera itself. It may be associated with episcleritis, but there is a great tendency for it to spread all round the ciliary region, and thus give it a dusky bluish appearance. This is due partly to increased vascularity and partly to thinning of the sclera, which allows the ciliary body to show through it. The cornea and ciliary body are more or less involved, and the disease runs a very protracted course. Recurrences are frequent, and the longer it remains the more softening and thinning of the sclera will take place. This may lead to closure of the angle of the anterior chamber and secondary glaucoma.

Owing to loss of resistance in the ciliary region, bulging will take place. There may be a local bulging only, or the whole ciliary region, with perhaps the cornea, may bulge as well, thus leading to the formation of a ciliary or anterior staphyloma. Such an eye becomes quite blind, and frequently painful.

Causes.—The disease is often associated with syphilis, gonorrhœa or tubercle, while gout and rheumatism are sometimes present.

Treatment.—This is much the same as described above under the head of Episcleritis. If the eye is blind and painful it had better be excised.

Gumma of the Sclera.—This may occur as a very rare manifestation in tertiary syphilis. As a rule the sclera is secondarily involved from a gumma of the ciliary body. Its treatment is the same as for gumma elsewhere.

Tubercle of the Sclera is also very rare as a primary affection, though the sclerotic is often affected secondary to tubercle of the choroid. Fresh air and good food is the best treatment, but if it breaks down it may be scraped, and an attempt made to save the eye, but it is usually better to excise it if it gets as bad as this.

Tumours of the Sclerotic are of great rarity. Fibroma is said to occur and also sarcoma, but the latter is nearly always secondary to sarcoma of the choroid. Occasionally melanotic spots occur on the sclera, and may give rise to a melanotic sarcoma. These spots are very frequently seen in negroes. Bony degeneration of the sclerotic may occur.

Injuries of the Sclerotic.—Wounds of the sclerotic are very dangerous. If the wound lies in the anterior part the ciliary body will be involved, and perhaps prolapsed; if behind this, there will be an escape of vitreous with a corresponding wound of the choroid and retina. The sclerotic may be wounded by a foreign body, or a stab with a knife or tool, or it may be ruptured by a blow on the eye such as with a fist, or by running against some hard substance.

It occasionally happens that the sclerotic is ruptured without the conjunctiva giving way. In some of these cases the lens is shot out of the eye and remains beneath the conjunctiva. There is always considerable extravasation of blood. Sometimes, owing to great bruising, it may be impossible to tell if the sclerotic is ruptured or not, but here the tension will be a guide. Still it must be

remembered that an eye which has just had a severe blow may be soft without any rupture having occurred.

If a wound of the sclerotic is present care must be taken to make sure that no foreign body remains within the globe; if it does it must be removed at all costs. Should a prolapse of vitreous, ciliary body, or choroid occur, it must be cut off. The question is often raised as to whether it is wise to stitch the sclerotic. As a rule it is better not to do so, because it is so hard that no matter how sharp the needle may be it is impossible to penetrate it without using pressure sufficient to cause a further loss of vitreous. It is quite a good thing to stitch the conjunctiva over the wound.

Should septic infection have taken place the eye will be lost, and will have to be excised. Should the eye be extensively damaged with no reasonable chance of recovery taking place, it is far better to remove it at once. It is not worth while running the risk of sympathetic ophthalmitis for the sake of keeping the shrivelled and blind remains of an eye which is useless for visual purposes. Strict confinement to bed is necessary during the healing of the wound.

CHAPTER XI

DISEASES OF THE RETINA

THE retina is a structure composed very largely of nerve elements and blood-vessels, and is of epiblastic origin. Any alteration of the blood supply may produce profound changes. It is liable to inflammation and atrophy; it can be injured by intense light or by blows and rupture; owing to its loose attachment to the choroid it frequently becomes detached; it is also liable to certain parasitic diseases and to some malignant growths.

Blood Supply of the Retina.—The arterial supply of the retina is derived from the central artery, which enters the optic nerve in the orbit and emerges at the papilla. It divides into numerous branches. Sometimes another branch, a cilio-retinal artery, enters the eyeball near the edge of the disc, and also spreads out on the retina. Owing to the fact that but little anastomosis takes place between the central artery and the choroidal vessels, any obstruction in the main trunk profoundly affects the well-being of the retina. Should the central artery get obstructed a cilio-retinal artery is most useful, as it prevents the retina being rendered entirely anæmic.

The blood is returned from the retina by veins which join together, forming the central vein, which runs with the artery and then empties itself into the cavernous sinus.

Hyperæmia of the Retina.—Venous engorgement may occur as the result of inflammation either of the optic nerve or of the retina itself, or as a part of general venous obstruction in cardiac and pulmonary disease. It is seen in its most extrème form in thrombosis of the retinal veins.

Anæmia of the Retina is most marked in cases of embolism or thrombosis of the central artery, which will cut off its blood supply, unless the eye happens to be provided with a subsidiary cilio-retinal artery, and this may keep up nutrition sufficiently to allow a certain part of the retina to remain functionally active. Less severe forms of anæmia are seen in cases of arterial degeneration, such as occurs in Bright's disease, while great contraction of the arteries is present in quinine poisoning.

Inflammation of the Retina, or Retinitis.—All forms of retinitis present certain common symptoms. This important structure becomes opaque and hazy and somewhat swollen; the vision is very quickly affected. The edge of the optic disc is blurred and the veins are enlarged. Often small patches of exudation are perceived, while if the inflammation is still more marked hæmorrhage may be present also. The retina is frequently affected secondarily when choroiditis is present. Nearly all cases of retinitis are due to some general disease or toxæmia; it is seldom a primary affection.

Syphilitic Retinitis.—This is a condition which sometimes occurs during secondary syphilis. We get the usual signs of inflammation present, viz. enlargement of the retinal veins and possibly some hæmorrhages, some opacity of the retina itself, and a distinctly blurred edge to the disc. This is partly due to the swollen retina, but is largely the result of seeing the disc through hazy media. This haze is due to the vitreous, which is found to be full of small dust-like opacities; they may be dense enough to produce much obscuration of the fundus, and there is great impairment of sight, especially when the light is bad. This condition is quite distinct from the choroido-retinitis seen in tertiary syphilis.

Treatment.—The disease which causes it must be vigorously treated. Leeches applied near the outer canthi will help to relieve local congestion.

Hæmorrhagic Retinitis.—Many forms of retinitis are

characterized by hæmorrhages, which occur as small flame-shaped spots or as larger extravasations of blood. They vary enormously in number and position. Sometimes only one or two small splashes are present, and these are usually situated at or near the macula; at other times the whole fundus is covered with them, especially where there is thrombosis of the retinal vein. If the bleeding be more

FIG. 69.—Subhyaloid hæmorrhage.

extensive a subhyaloid hæmorrhage may develop and may burst into the vitreous (Fig. 69).

Causes.—There is in most cases some morbid state present such as cardiac or renal disease, leading to atheroma of the arteries and high arterial tension. Sometimes hæmorrhages are seen in cases of acute or chronic glaucoma. A large number of hæmorrhages, with many patches of exudation, are frequently to be seen in diabetes. Many cases follow pregnancy, and are usually associated with albuminuria (Fig. 71). Progressive myopia is often found to be complicated with

hæmorrhages at or about the macula, while extensive hæmorrhages occur in leucocythæmia (Fig. 70).

Prognosis.—This is always bad. The least unfavourable cases are the puerperal ones, and it is possible that the vision as well as the life of the patient may be saved for many years provided active measures are taken, but if not either blindness or death will result. In hæmorrhagic glaucoma the

FIG. 70.—Hæmorrhagic retinitis.

local condition may be quite sufficient to account for the whole of the appearance seen in the retina, and provided this can be successfully dealt with, but little permanent damage may result. It is always well to remember that these cases are unfavourable for operation owing to the liability there is for a large intraocular hæmorrhage to take place as soon as the tension is relieved, while the vessels are usually atheromatous as well. The myopic cases are very unfavourable as regards sight; profound damage has in any case been done to the retina by extreme stretching,

while the inflammatory changes produced thereby have been severe enough to cause the retinitis and the hæmorrhages. Should a hæmorrhage occur actually at the macula it will blot out central vision, and recovery from this is unlikely unless it is very minute. In the renal and diabetic cases the prognosis is bad. Considerable changes have probably occurred in the kidneys before the eyes were affected.

Fig. 71.—Albuminuric retinitis. (After Wecker and Masselon.)

These changes may be due to nephritis, the result of cold, scarlet fever, or some acute poisoning; or may follow a granular contracted kidney which is hard and fibrous, and which has led to chronic increased arterial pressure. It is seldom that people having the latter condition survive as long as eighteen months or two years, whereas the cases due to acute nephritis, puerperal or otherwise, sometimes die of uræmia, but very often recover and live for several years. The cases due to cerebral tumour and

meningitis are of course unfavourable, and the condition which causes it usually has a fatal termination. A hæmorrhagic glaucoma is the worst form of the disease met with. It will thus be realized that a hæmorrhage in the retina, no matter what its cause, is of the greatest moment, and except in those which follow a direct blow (which has probably damaged the eye otherwise) they mostly indicate a serious condition, and practically always cause deterioration of vision. It must never be forgotten, however, that small hæmorrhages occurring at any part of the retina other than the macula may at first give rise to no perceptible defect of sight, so that in any case in which retinitis is considered possible it should never be excluded until the whole fundus has been thoroughly searched with the ophthalmoscope. In diabetes death from coma is very likely to occur.

Treatment.—This must entirely depend upon the cause. Leeches, or the Heurteloup artificial leech, may be applied to the temple in all cases; salines should be given and some form of mercury except in the renal cases, when great care has to be exercised if this drug is used. Calcium lactate has some effect upon the coagulability of the blood, but its use is very questionable in cases due to an altered blood condition. The renal cases must be energetically treated with diaphoretics and diuretics, and every care taken against chills. In all these cases much fluid should be taken so as to dilute the urine as far as possible, and thus relieve the kidneys of highly concentrated chemical products. In the puerperal cases the treatment must be left to the obstetric physician to decide, but unless the uterus be quickly emptied (which may cause the death of the child), it is very likely that the life of the mother as well as that of the child will be lost. In diabetic cases the disease must be treated generally.

Retinitis due to Leucocythæmia.—It frequently happens that changes of the retina are seen in this disease; the whole fundus is very pale and the veins are considerably

enlarged. The retina has an opaque appearance; small round white spots are scattered about, each of which is surrounded by some hæmorrhage. The vision will be profoundly affected if the macula be involved, otherwise it may show but little sign of defect. Local treatment is of no avail.

Retinitis Proliferans.—This is a condition in which there is extensive development of connective-tissue in the retina; large bands of it stretch themselves in all directions. The actual cause of the disease is somewhat obscure, but is probably the result of hæmorrhage which becomes organized. These may lead to puckering of the retina and eventually to detachment. Many cases, however, show a tendency to improve, and often far better vision is obtained than would appear to be possible.

Treatment.—This is much the same as the treatment of any other form of retinitis. Local depletion may be carried out by leeching, while such drugs as calcium lactate, iodide of potassium and mercury are sometimes useful, and appear to have a beneficial effect.

Retinitis Circinata is the name given to a form of retinitis in which there is a circinate patch of retinitis at or about the macular region. It has a greyish-yellow appearance, and often hæmorrhages are present. It occurs almost entirely in old people. As a rule it is progressive, and ultimately leads to loss of sight. It is essentially of a degenerative nature, and little or nothing can be done to improve the condition.

Retinitis Pigmentosa is a degenerative rather than an inflammatory disease, and it runs a very chronic course. It seldom occurs in any one without a well-marked family history, for it is one of the most marked of the hereditary diseases affecting the eye. It usually starts in young people, though it may commence to show itself at any age, and when it does come on blindness is almost certain to result after years of progressive failure of sight (Fig. 72).

Symptoms.—The first symptom of which these patients

complain is night-blindness. They experience great difficulty as soon as ever the light fails; the light sense becomes so diminished that although they are well able to see to go about during the daytime, yet as soon as ever the sun sets they are almost incapable of avoiding even large objects. If now the field of vision be examined it will be

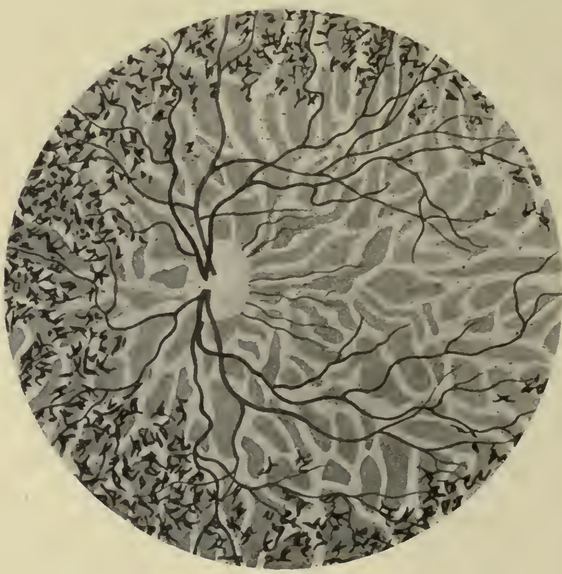


Fig. 72.—Retinitis pigmentosa.

found to be contracted from the periphery towards the centre.

As the disease progresses the field of vision becomes so small that nothing but central vision is left; and although at the very centre of the field the sight may be quite good, yet because of its great restriction the patient is virtually blind, for it must be remembered that central vision without a field is almost useless. Such vision is sometimes termed "telescopic," as it resembles what would be present if we were to look through a length of narrow tube and could only

see what was in view at the end of it. After a time even this small amount of sight fails, and the patient becomes totally blind. Both eyes are always affected, and nothing is known which will arrest its progress.

An ophthalmoscopic examination shows very characteristic signs. The first thing to be noticed will be that at the extreme periphery of the fundus patches of pigment are scattered about. These are quite small and closely resemble bone corpuscles. As the disease advances the fundus appears pale and the retinal vessels constricted, so that both arteries and veins are smaller than normal. If a vessel be traced it will be seen to run beneath the pigment, thus proving that the pigment is really in the retina and not in the choroid; this is an important point to remember when trying to ascertain exactly where a patch is situated. If it were in the choroid the retinal vessels would of course run over the pigment.

The disc then shows signs of atrophy, and assumes a curious and somewhat characteristic waxy appearance, and by this time the vessels may be reduced to lines as fine as threads. Owing to the atrophy of the retinal pigment it frequently happens that the choroidal vessels are distinctly visible. The amount of pigment deposited in the retina is variable. Sometimes it is large in amount and extends up to the disc, at other times there is far less and it may only be seen quite at the periphery, while cases are seen occasionally presenting all the symptoms of retinitis pigmentosa with no pigment visible at all; these are termed cases of *retinitis pigmentosa sine pigmento.* The pigment is supposed to be derived from that of the retinal, which for some reason wanders away from its usual situation and becomes deposited in an irregular way through the retina, both along the nerve fibres and also the vessels. The retinal as well as the choroidal vessels are diminished in size, and it is possible that the choroid may really have a good deal to do with the development of the disease.

The lens is nearly always affected to a greater or less

extent, and it usually assumes the form of a posterior polar cataract, but later on it may become completely opaque. It should be remembered that on account of the limited field of vision a very small amount of lens opacity may cause a profound limitation of vision, so that it is frequently quite justifiable to remove the lens even when the opacity is quite small, and thus considerably improve the vision.

Etiology.—It has been before remarked that the disease is hereditary. It generally attacks several members of the family, and is scarcely ever seen as an isolated case. Males are far more frequently affected than females, though the latter nearly always transmit it, without themselves being affected. It is sometimes seen when there is marked consanguinity; there is generally a well-marked neurotic family history, with perhaps epilepsy and insanity present as well.

Treatment.—There is no known remedy which can be said to be any real good. Strychnine and other nerve-tonics may be given, and some cases have been recorded which have appeared to improve, or at least not get worse, when the constant current was regularly employed. Nothing is known which will really arrest the atrophy, which invariably goes on to blindness. Some cases appear to have been benefited by subconjunctival injections of cyanide of mercury.

Retinitis Punctata Albescens is very similar to retinitis pigmentosa. Its symptoms are identical, but the fundus, instead of having pigmentary changes, gets covered with numerous small white dots; sometimes, however, there are some pigmentary changes as well. The two diseases are essentially the same, with the exception just mentioned; it occurs in the same sort of people, it leads to blindness like the other, and its treatment is equally unsatisfactory.

Embolism and Thrombosis of the Central Artery of the Retina.—These two conditions may be taken together, for they lead to identical symptoms. If the artery gets

suddenly blocked the vision disappears. On ophthalmoscopic examination the artery or a main branch of it is entirely destitute of blood, and the shrunken and empty vessel can be seen to run along the retina. The fundus is anæmic and white, with the exception of the macula, for here the retina is so thin that the red choroidal reflex is seen beneath it. On account of its being set up against the anæmic and œdematous background it appears to be quite red, and is appropriately termed the "cherry-red

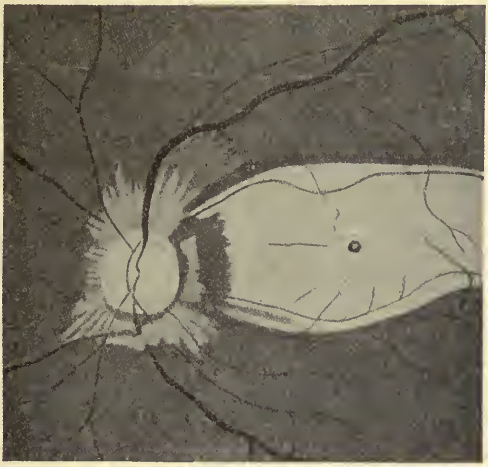


Fig. 73.—Cherry-red spot at macula.

spot." Sometimes a small amount of blood will pass the obstruction and may be seen moving along like a broken column in a thermometer glass. This characteristic appearance of the fundus soon changes. The cherry-red spot appears to fade in a few days due to absorption of the œdema, which quickly came on when the obstruction took place; the macula is really the same colour as it was before, but inasmuch as the red choroidal reflex is now visible all over, so the spot fails to stand up in relief as it did at first. Blood may by this time have got into the

vessels, but if the obstruction is very complete the fundus may be as anæmic as ever.

It is quite impossible to say from the ophthalmoscopic appearance whether the case is one of embolism or of thrombosis, but the history may give a clue to it as well as the general condition of the patient. In embolism there is often evidence of valvular heart-disease, while in thrombosis there is generally arterio-sclerosis and an atheromatous condition of the arteries generally, with perhaps renal disease.

Prognosis.—This is decidedly bad as regards sight, for the retina is generally left anæmic sufficiently long to be functionally destroyed even though the circulation be subsequently more or less restored. Inasmuch, however, as there must be profound changes in the vascular system before such a condition is possible, it may readily be understood that there is not much chance of recovery, and if it is due to thrombosis, most likely the condition which caused it in the first instance will go on acting, and the thrombosis will extend and perhaps cause blocking of a cerebral vessel. If it is due to an embolism there is not much chance of its beco ing dislodged, and it will remain and will permanently close the vessel. Should there be a branch only of the retinal artery obstructed, that part of the retina which is supplied by the blocked vessel will be the only part affected, and will take a wedge-shaped piece out of the field of vision.

Treatment.—From the very nature of the disease it is obvious that but little can be done. Some people have recommended paracentesis of the anterior chamber, with the idea of suddenly lowering the tension of the eyeball, and perhaps in this way allowing the embolus to move in; but even if this were successful it could not do more than drive the embolus a little further forwards, and that would probably not help matters much. Unless this were done immediately it is manifest that it would have no effect upon an organized clot which had been there for more than a few minutes. Massage has been recommended with the same idea, but it

may be taken generally that there is no treatment likely to avail. If the blood is sufficiently altered, or the vessels sufficiently diseased to allow of clotting to take place in them, it is sufficient to indicate considerable disease of the whole system, which had better be treated from its medical aspect.

Thrombosis of the Retinal Vein is a serious matter, and, like the same condition in the retinal artery, it is caused by disease of the vascular, cardiac or renal systems. It produces the most intense engorgement of the veins of the retina with large hæmorrhages all over the fundus. Atrophic changes quickly take place until the retina and optic nerve become functionally inactive and the retinal arteries are reduced to thread-like structures. It sometimes happens that thrombosis is confined to one branch of the retinal vein only, and when this is the case the portion of the retina which is drained by that vein is the only part affected.

The *prognosis* is bad and the *treatment* is nil, except so far as any general condition which may cause it can be affected.

Sclerosis of the Retinal Arteries.—Considerable attention was called to this condition by Marcus Gunn, who appropriately termed them "silver wire arteries." It is usually associated with syphilis or with atheroma of the whole arterial system, but because they can be so easily seen they form a valuable index to the general condition, and a careful ophthalmoscopic examination often gives the first indication of renal and arterial disease. The lumen of the arteries get constricted, and they are much more likely than healthy vessels to give way or to get occluded. The arteries show these changes more than the veins, though both may be affected.

Various poisons affect the retinal vessels in a marked manner. The blindness due to quinine is well known. After a poisonous dose of the drug the retina becomes intensely anæmic, and all the vessels are constricted to such an extent that the circulation is almost, if not entirely, arrested. Blindness rapidly becomes absolute, and when

a person who has suffered from it regains consciousness, the sight has gone. If the effect of the drug passes off quickly, as it may do if the dose has not been an excessive one, the vision may be restored in part or entirely, but if the effect is prolonged for a considerable time, little or no recovery will take place. The fields of vision may be reduced to as great an extent as in retinitis pigmentosa, while the optic nerve becomes white and atrophic, and the vessels quite small. Many cases tend to show some recovery from the absolute blindness which at first comes on, but all the improvement which is likely to take place will have done so in the course of a few weeks. Exactly what the poisonous dose of quinine is, is very difficult to determine, for many cases of blindness have been produced by a dose smaller than what has been habitually taken by people suffering from malaria. It is probably never wise to give more than twenty grains for a dose, and it is far safer not to give anything like so much unless the patient is habituated to the use of the drug.

Treatment is of very little avail. The obvious thing to endeavour to do is to produce dilatation of the much constricted vessels, so that there shall be sufficient blood supplied to the retina to maintain its nutrition until the effect of the drug has passed off. This is very difficult to do, and it is useless attempting it after the damage has been done. While the general poisonous effects are present, neither the patient nor any one else is aware that the eyes are affected. Such drugs as nitrite of amyl will dilate the retinal and other peripheral arteries, but the effect is far too transitory to do any real good. Drugs which will increase the arterial pressure, such as strychnine and digitalis, may be given, though it is very doubtful if much good will result.

Among other drugs and chemicals producing similar poisonous effects are male fern and bisulphide of carbon.

Tumours of the Retina.—*Tubercle of the Retina* may possibly occur as a primary affection, but if it does it is

exceedingly rare. Tubercle of the choroid is common enough in children, and the retina will get involved in a secondary manner from contact. It is quite likely that some of the cases of so-called pseudo-glioma are really tubercular in origin, but it is very difficult to distinguish them from true glioma. In any case the eye will be lost, and on account of the possibility of its being a malignant growth it is as well to excise the eye at once. If the diagnosis of tubercle can really be made, tuberculin and other treatment for tubercle may be tried.

Glioma of the Retina.—This is a most serious condition which occurs in children. It may be present even at birth, and may occur in any child up till about ten years of age, but it is very rare after the fifth year. Like most other malignant diseases its origin is unknown, but it is very likely to develop in more than one member of the family, and often both eyes are affected. Owing to the age of the patient when it first appears it is seldom recognized until it is fairly far advanced. As a rule the first sign of mischief is noticed by the mother or nurse, who sees a white reflex in the pupil very much like the reflex of the tapetum lucidum in a cat, and so the condition has been known as the "amaurotic cat's eye." Even when this is seen, owing to ignorance, the child is often not brought to the surgeon at once, and so the disease is allowed to progress. With the ophthalmoscope the white reflex is at once recognized in the eye, which otherwise appears to be quite healthy. The anterior chamber is of normal depth (in the early stages) and the eye itself shows no sign of congestion, neither is it painful. The growth has a white appearance with blood-vessels running across it, and with the dilated pupil it frequently happens that the growth can be seen by means of the oblique illumination. If things progress still further the eye may become congested, hard and painful, and the growth will eventually burst through the sclerotic, grow with great rapidity, and speedily cause death from exhaustion. It has a far greater tendency to

spread backwards along the optic nerve than forwards, and it will thus get conducted to the brain. This will give rise to an intracranial growth, and death may take place from this cause, and with the usual cerebral symptoms.

The growth in the eyeball sometimes undergoes degenerative changes, and it is no uncommon thing to find calcareous and necrosed masses in the tumour. Very rarely it degenerates faster than it grows, and in this way it tends to spontaneous cure, though the sight will, of course, be lost and the eyeball shrunken.

[I have seen a case of a child whose right eye was excised when six weeks old for glioma. The other eye was carefully examined under an anæsthetic and nothing was seen. The growth in the excised eye was an undoubted glioma. A few weeks later a tumour was seen in the other eye. The parents refused excision, and a certain fatal result was looked for. Five years later the child was seen again with the remaining eyeball shrunken, blind and painful. It was excised and was found to be filled with degenerated glioma tissue, but the optic nerve was not affected, neither did the patient show any sign of the growth having spread beyond the eyeball.]

Metastatic growths are not seen.

Prognosis.—This may be considered as hopeless unless the eye is excised at once, and even if this is done it is impossible to be sure whether it has already spread to the brain. Sometimes the optic nerve is obviously enlarged, and the cells of the growth can be seen to be situated in it. Such a case is hopeless, recurrence will take place at the end of the nerve as well as within the skull. Even after the eyeball has been removed, and the stump of the optic nerve is to all appearance healthy, it is never wise to give too sanguine a prognosis until the child has passed an age beyond which glioma has never been known to occur, say about ten years old. Until then it is quite impossible to make sure that the patient will not get a growth in the remaining eye.

Diagnosis.—This is often very difficult. A chronic suppuration or mass of tubercle in the eye is so like a glioma that it is termed a pseudo-glioma by some. In the latter condition there may be some retraction of the angle of the anterior chamber and some sign of old or recent iridocyclitis, whereas in true glioma these inflammatory symptoms are as a rule absent. The tension of the eyeball may be anything, hard, soft or normal in both conditions, according to the stage of the disease, so that this does not give much assistance. In both conditions the sight is hopelessly lost; in the pseudo-glioma cases the globe will shrink and become painful, and for that reason will ultimately have to be excised, so that really the diagnosis is of comparatively little importance, for in either case the eyeball should be excised, after which its true nature may be determined with certainty. Inasmuch as there must be considerable doubt in many cases before excision, it is infinitely better to excise these eyes at once. Should a case be left because it is thought to be a pseudo-glioma when really it is a true glioma, all chances of saving the patient's life will be lost. If, however, a pseudo-glioma is excised in mistake for a glioma no harm is done, for the eye will have to be excised a little later, and no one could swear to the fact in many cases that it really was a pseudo-glioma until it was examined after removal.

Treatment.—Immediate excision is the only thing that gives any hope of saving the life of the patient. Nothing can save the sight. In removing the eye the optic nerve should be cut as far back as possible, that is, close to the optic foramen, and if the growth shows any signs of infiltrating the nerve or of spreading in the orbit, the whole of the contents of the orbit must be exenterated. While the child is under the anæsthetic, *and before the affected eye is removed*, the other should be most carefully searched with the ophthalmoscope for any sign of growth in it, and for this purpose the pupil should previously have been dilated with atropine. It is obviously useless to excise one eye only

if the other contains a glioma; and inasmuch as permission for the removal of both will not have been obtained from the parents, the operation should be delayed until this has been done.

Effects of Excessive Light on the Retina.—The exposure of the eye to excessive light produces very profound effects on the retina. This condition is often called "eclipse blindness," because of the frequency of its occurrence after a solar eclipse, for at such times people are apt to look directly at the sun, and are often proud of being able to stare at it longer than some one else. Exactly the same effect is seen after exposure of the eyes to the intense glare of the electric arc. It is within the experience of every one that directly after looking at a bright light a central scotoma or blind spot is developed; thus, if a white wall or ceiling be looked at, right in the centre of vision is seen a black spot with ill-defined edges. After a few minutes this scotoma fades and the sight is restored to what it was. If, however, the exposure be very much more prolonged or the light very intense, this scotoma will remain and may become permanent. This is due to organic changes in the retina which consist of destruction of the nerve elements. On ophthalmoscopic examination certain changes become apparent, and a central retinitis is produced; at times small hæmorrhages are seen in the immediate vicinity. This is entirely due to the destructive influence of the intense light, which is in the highest degree detrimental, and may cause permanent blindness in exactly the same way as an explosion or any intense noise may cause deafness.

Treatment.—In this condition it is obvious that preventive treatment is better than anything, and there is no difficulty in avoiding dangerous lights, but to cure it when once established is impossible. People should be warned of the danger of excessive light, and no one should attempt to look at the sun without the interposition of thickly smoked glass. Men who are employed with search-lights and electric welding should be made to wear thick

protecting glasses, and then their work may be carried on without danger. After the mischief is done the only thing is to keep the patient in bed in a dark room, and to put a bandage or very dark glasses over the eyes. A low diet should be enjoined and mercury should be given internally. Under this treatment much of the sight may be restored, but if much real damage is done a permanent central scotoma will be left.

Electric Ophthalmia.—This is another curious condition which is not infrequently seen in men who are engaged in burning the powerful search-lights such as are used in modern men-of-war. Although very dark shields are used for the inspection of the light, yet sometimes men are careless enough to attend to it with the shields up. Nothing may be noticed at the time, but a few hours afterwards the whole eye becomes red and painful and very irritable. In a short time the conjunctiva is intensely chemotic and protrudes through the lids. The pain and smarting of the eyes is intense, while some muco-purulent discharge is developed. The case looks like one of gonorrhœal ophthalmia in the early stages. The cause of the condition is what virtually amounts to a severe sunburn of the conjunctiva and cornea. The epithelium becomes stripped off, the nerve endings exposed, and the condition is similar to what occurs in an abrasion of the cornea, but is very much more severe. Fortunately the epithelium quickly grows again, and as soon as the nerve endings are covered all the symptoms disappear.

Treatment.—The patient should be at once placed in the dark and some soothing lotion such as cold boracic should be used. Atropine will give more relief than anything, as it always does in any superficial injury of the cornea. On no account should strong and astringent remedies like nitrate of silver, sulphate of zinc or alum be used, while cocaine is very detrimental, owing to the fact that it tends to desquamate a normal cornea, and will certainly help to delay healing here. If treated properly the patient gets well in a day or so.

Effect of Electric Light on the Eyes.—There is a very general impression among people that the ordinary incandescent electric light is trying and injurious to the eyes, and the surgeon is frequently asked his opinion on the subject. As a matter of fact there is nothing whatever to complain about in the character of the light. It is steady and does not pollute the atmosphere, while it can easily be made sufficiently intense to allow of things being seen without straining the eyes. It has, however, this one real disadvantage, viz. that because of the ease with which it can be put on people often use their eyes for much longer periods of time than used to be customary, and so they overtire them and make them ache, and then blame the light for it.

Cysticercus of the Retina is derived from the Tænia Solium, and is very rarely seen in this country. When it does appear it shows as a bluish-white tumour which projects into the vitreous and detaches the retina which is stretched over it. On careful ophthalmoscopic examination curious wave-like motions may be seen, and there are often fine web-like opacities in the vitreous. If the cyst grows it is apt to burst into the vitreous and destroy the eye. If it is situated at a position which may be got at, an incision may be made through the sclerotic and the contents removed, when the characteristic hooklets will confirm the diagnosis. Unless this can be done the eye will be destroyed, and had better be removed.

Detachment of the Retina.—The retina may become detached from excessive stretching of the eye as in high myopia, or as the result of a tumour growing beneath it and lifting it up. Sometimes a blood-clot or exudation will cause it to become raised. There are, however, two places from which it never loses its hold—one is the optic nerve, and the other is the ora serrata; between these two points it is only very slightly attached to the choroid, and it does not take much to cause it to separate.

Myopia is the condition which is responsible for by far the greater number of detachments. As the eyeball increases

in size, so the retina becomes more and more stretched; as it is not elastic and is only large enough to cover the interior of a globe of normal size, after a time a tear will take place and a large portion of it become detached. This condition is scarcely ever seen except in myopic eyes, but occasionally it occurs in those which are emmetropic or even in hypermetropic. The detachment may be confined to one

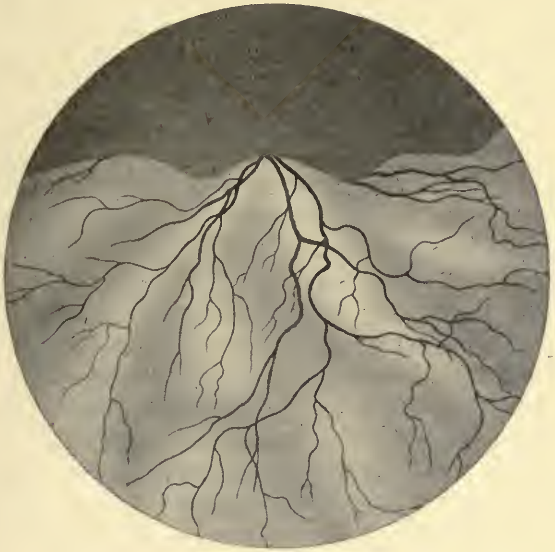


Fig. 74.—Detachment of the retina.

segment of the eye, or may be total, and then the retina assumes an infundibular shape, being attached at its apex to the optic disc and at its base to the ora serrata. The sight is profoundly affected, and the field of vision is lost over the separated area. If once any portion of the retina becomes detached, fluid collects beneath it and tends still further to separate it, so that after a time the retina will become entirely detached and the eye quite blind. The vitreous in detachment cases is nearly always diseased and is more fluid than normal. Ophthalmoscopically the

detachment is easy to see. If the retina or any part of it be separated, the refraction at that part will be very different from that of the optic disc or undetached portion, and as it will be much nearer the observer, so a greater or less degree of hypermetropia will be present.

In order to measure the height of the detachment, the direct method must be used, and a note made of the weakest minus or the strongest plus glass with which the disc can be seen. Next turn to the part in which a detachment is suspected and again see the lens with which it may best be seen. If there is any difference between the two glasses it shows that the objects are at a different level. Thus suppose the disc in a myopic eye cannot be seen on direct examination with a weaker glass than a -10, and suppose the retina on the detached part can be well seen with a $+ 10$, but with nothing higher, that means that there is a difference of 20D in the refraction at these different parts of the eye, and as one millimetre corresponds to 3D, this would mean that the detached retina was raised between six and seven millimetres.

If the detachment is recent the retina may retain its red appearance, but the vessels running over it are so very sharply cut and so much more distinct than the others, that any one with experience could hardly fail to notice it. If the detachment has been there longer it assumes a pale grey appearance, which is still more characteristic. It should be remembered that the detached portion can always be seen with a glass which shows up the disc, that is, if the observer uses his own accommodation. Care must be taken to use the weakest $-$ glass or the strongest $+$ glass possible whenever an observation is made on the comparative heights of objects within the eyeball.

It becomes of the greatest importance to be able to say for certain what is the cause of the detachment in any individual case. So frequently a neoplasm in the eye shows itself only by means of a detached retina, and it is sometimes extremely difficult to say whether the detachment is a

simple one or is due to something growing beneath it and raising it.

Each case has to be decided on its own merits, and nothing but the skill and experience of the surgeon will be able to lead to a right conclusion in any case. There are one or two rules which may be mentioned as aiding the diagnosis, but these have so many exceptions that reliance should not be placed on any of them if other things point to a different conclusion. Perhaps the most reliable of them all is the appearance of the detachment. If it is loose and waves about, as the eye is moved, the chances are that there is nothing but fluid beneath it; if, however, it is firm and solid in appearance, it is more likely to be caused by a solid growth pushing it forwards. Should a detachment occur in an eye which is hypermetropic, or emmetropic, it is very suggestive of a growth, as simple detachments are exceedingly rare with this condition of refraction. If the eye is myopic a simple detachment is to be suspected.

The tension of the eye is most fallacious. Some people have affirmed that a detachment with a plus tension is a growth, and with a minus tension is a simple one. No greater mistake could be made, for if one waited until a growth caused a glaucomatous condition, it would in many instances be so far advanced that the life of the patient could not be saved, and in addition many eyes containing tumours are never harder than normal, many have normal tension, and quite a number minus tension. The tension entirely depends upon whether the angle of the anterior chamber is closed or not, and has nothing directly to do with the fact that the eyeball may be half full of growth. In many tumour cases the angle is never closed, especially in those in which the growth is far forwards and involves the ciliary body.

It is also not uncommon for an eye suffering from iridocyclitis with secondary glaucoma to have a detached retina. It may be said that if the eye is otherwise healthy an increase of tension is perhaps in favour of a growth, but very little

reliance should be placed upon it unless it tends to confirm the result of other investigations. It will thus be seen that a correct diagnosis of the condition of affairs is very complicated, but is very important, and the student should never lose an opportunity of carefully examining every eye he can with detached retina.

Traumatism of the Retina.—Injuries to the retina are occasionally produced by blows from blunt objects, such as a cork flying out of a bottle. Frequently the pupil becomes dilated, or partially so, and the retina œdematous. After a time the œdema may pass away and the sight be restored; if the injury is severe, permanent damage is likely to be produced.

Another curious condition due often to injury, is known as "Holes at the Macula." These holes have sharply cut edges, and through them the choroidal vessels are seen. The sight is considerably impaired, but as a rule the vision is better than the ophthalmoscopic appearance would lead one to anticipate. The same condition has been seen after an attack of iridocyclitis or other inflammatory condition without injury. It admits of no treatment.

CHAPTER XII

DISEASES OF THE OPTIC NERVE

The optic nerve extends from the optic chiasma at the base of the brain to the optic papilla in the eyeball, so that it has an intracranial and extracranial portion.

Inflammation of the Optic Nerve, or Optic Neuritis, is the most frequent pathological condition seen in this structure, and as the head of the optic nerve is visible, it is of great use in determining the condition of the contents of the cranium. Optic neuritis may be due to many causes, and although the actual appearance may give the clue as to the cause of the condition, yet all cases have much in common.

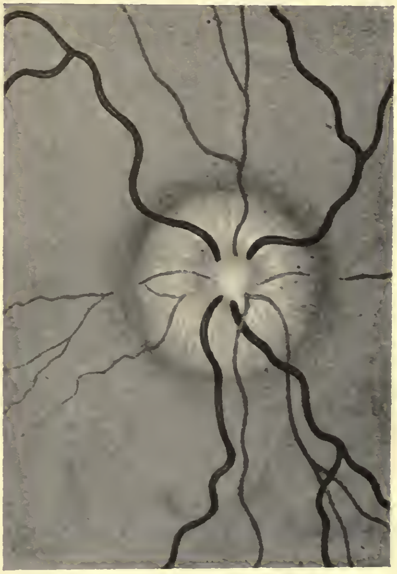


Fig. 75.—Optic neuritis.

The edge of the disc, instead of being clear and fairly sharply cut, is ill-defined and swollen, and the papilla itself has an œdematous and woolly look. The vessels, and especially the veins, are dilated and engorged with blood, and there may be some œdema of the retina in the immediate neighbourhood of

the disc. As the case progresses the swelling increases, and the vessels become more distended and tortuous, while frequently small hæmorrhages occur in the retina or on the disc. This condition is known as "chocked disc." It is seldom possible to say from the intensity or otherwise of the neuritis what the vision is like. Sometimes such patients may complain of no defect of sight at all, and yet intense neuritis is present; at other times, with very slight congestion, the vision may be profoundly affected. The field of vision also varies very much in different cases. Attacks of temporary loss of vision are sometimes complained of.

Causes.—The most intense examples of "chocked disc" are seen in cases of cerebral or cerebellar tumour, and here the nerve head may be several dioptres higher than the surrounding retina, when measured with the ophthalmoscope. Meningitis is also a frequent cause of optic neuritis. Much discussion has lately taken place as to whether in cases of tumour of the brain with double optic neuritis, the inflammation is the most marked on the side of the growth or on the opposite side. Some hold with Sir Victor Horsley that the neuritis is most marked on the side on which the tumour is present; Leslie Paton and others hold that it is more intense on the opposite side. It is an important diagnostic feature, for without any definite localizing symptoms it is often very difficult to determine in which hemisphere a tumour is situated. Most observers agree with Sir Victor Horsley, and look upon the side on which the neuritis is more marked as being the probable side on which the growth is situated, but no doubt there are exceptions.

Optic neuritis is seen in many other conditions besides intracranial disease. It is frequently caused by renal disease, and in some cases of poisoning such as lead. Syphilis not infrequently produces it, while pressure from orbital tumours, necrosed bone, exostoses, etc., are often the cause. Exposure to cold is said to produce it, but if it does it is probably secondary to acute nephritis. It has been seen to follow all sorts of diseases, such as scarlet fever, measles,

malaria, etc., but in most of these cases nephritis will be found to be present, and it is this rather than the primary disease which is really responsible for its development.

Certain diseases of the nervous system, such as disseminated sclerosis, locomotor ataxy, etc., which lead to primary optic atrophy, sometimes produce optic neuritis previously. Leber's disease, or hereditary optic atrophy, is a curious condition, which runs in families and leads to blindness. Sometimes there are signs of optic neuritis present before the atrophy develops.

Retrobulbar Neuritis is that condition which gives rise to all the symptoms of optic neuritis without any visible signs of disease in the disc. The patient complains of deterioration of sight, and on examination a relative or absolute central scotoma is found. After a time signs of optic neuritis develop to a greater or less degree, followed by atrophy, which may be partial or complete. At first it may be difficult to find out the cause of this condition, but it is frequently found to be due to suppuration of one of the air sinuses at the base of the skull. Sometimes it is the earliest symptom of some form of spinal atrophy particularly disseminated sclerosis. Various toxæmias, either from drugs (such as tobacco) or other causes, are liable to produce it.

But little can be done for treatment directly. If the cause of the condition is apparent, the disease must be treated accordingly.

Toxic Amblyopia producing Retrobulbar Neuritis. This condition is so common in those who take tobacco to excess that it merits a paragraph to itself. It has been mentioned above as a cause of the disease, which has very definite symptoms. It usually occurs in persons who have smoked for many years. In England it is seldom seen in any but pipe-smokers. Cigars will produce it, but they are too expensive to allow of most people smoking them to excess. Cigarette-smokers are not often affected by tobacco amblyopia, but this is probably due to the fact that their hearts are more quickly affected by this form of smoking

than the eyes, and the former stops them before the latter are affected. It is quite possible to get it from the taking of snuff, or from chewing tobacco, but as these practices are distinctly limited in these days, cases of it are seldom seen. Patients may smoke heavily for many years without any defect of sight coming on, but when their health becomes affected, or they are badly fed, then often enough poisonous symptoms supervene. These people come complaining that their sight for all purposes has lately failed. They cannot see well at a distance, neither can they see any better for near work. Reading is particularly difficult, and no matter how well the refraction or the presbyopia be corrected, little, if any, improvement of vision is produced. There will in these cases be found to be a central scotoma for green or red, and generally in both colours. If a small piece of red or green paper be held up and the patient *with one eye only* (the other being covered) be asked to look directly at it, he will probably fail to recognize the colour; but if the object be moved while he is still staring at the same place, he will most likely recognize the colour when it falls on some part of the retina other than the macula. As a rule the scotoma for green appears before that for red. On ophthalmoscopic examination but little is seen abnormal to account for such a serious deterioration of vision. The optic disc is sometimes pale on the temporal side, but this is not always recognizable. When all these symptoms are present in a smoker, toxic amblyopia may with certainty be diagnosed. The most characteristic thing is the failure of both near and distant vision with nothing else to account for it. Sometimes the scotoma may be quite large, but it is always central.

The actual lesion is a retrobulbar neuritis, leading later to atrophy of some of the nerve fibres supplying the macula, and a development of interstitial connective-tissue in the nerve itself.

Causes.—Although tobacco is the chief and most potent cause of the trouble, yet it is frequently associated with

chronic alcoholism, which itself may produce a toxic amblyopia, much the same as tobacco alone may produce it, but the combination of the two is far more potent than either of the drugs separately. There are many other drugs which produce similar symptoms.

Treatment.—No treatment is of the slightest avail unless the use of tobacco in every form be entirely given up. No half-measures are of any avail, for when once poisoning has been set up, it only requires a very small quantity to prevent recovery taking place, therefore the person who promises to diminish the amount he uses is scarcely more likely to improve his sight than if he smoked as usual, though under the latter conditions his sight would get worse more quickly. The most explicit directions must be given to them. Patients find it convenient to imagine that it is the smoke getting into their eyes which does the harm, and they will substitute a long pipe for a short one. Others will leave off smoking as directed, and will then take snuff or will chew tobacco, and both they and the surgeon will wonder why no improvement takes place, for they generally take care not to mention the fact. Others will lie freely on the subject, but the fact remains that they will not get their sight back while tobacco is entering their system. They should be forbidden to travel in smoking carriages or to sit in rooms where the atmosphere is thick with tobacco smoke. At the same time strychnine may be given, and large quantities of water should be drunk, as is strongly insisted upon by Charles Wray, so as to flush the kidneys and so aid elimination. The bowels should be kept freely open. The use of alcohol is extremely bad, and this should be prohibited also. If these directions are carried out the chances are that the sight will be entirely restored. It is very dangerous for the patient to recommence smoking, for although he may recover a second or even a third time, it is certain that a stage will be reached after which the vision will not come back, and permanent and irreparable damage will be done to the sight through atrophy of the nerve, though total

blindness may not result. After recovery it occasionally happens that a patient may suffer no apparent harm when he takes to smoking again, but this is rarely the case.

The possibility of tobacco amblyopia in women must always be borne in mind. They stand tobacco far less well than men, and are very liable to failure of sight if they smoke much. It sometimes happens that boys and young men may develop the disease in a few weeks after they commence smoking.

It is extremely important to remember that owing to the central scotoma for red and green serious accidents may occur in such men as sailors and engine-drivers because of their inability to see signal lights at a distance.

Atrophy of the Optic Nerve may be primary or secondary, and if complete renders the eye totally and irreparably blind.

Primary Optic Atrophy occurs as the result of spinal affections, such as locomotor ataxy, disseminated sclerosis, lateral sclerosis, and general paralysis of the insane. Sometimes it is a syphilitic manifestation when there are no other signs of disease of the central nervous system.

In this disease the nerve head becomes as white as paper, the physiological cup if present is not filled up, and the arteries and veins of the retina are very much reduced in size in most cases; sometimes they appear to remain about normal. The sight soon becomes defective, and the field of vision reduced, and often in a most irregular manner. Near and distant vision are equally affected, and as the disease progresses total blindness supervenes.

Secondary Atrophy of the Optic Nerve is seen to follow optic neuritis. After the symptoms of neuritis have disappeared the nerve gradually becomes paler and paler, until the sight is completely lost. After this has taken place the signs of the old neuritis are visible. The physiological cup is filled up, the edge of the disc is nothing like so sharply defined as in primary optic atrophy, while the signs of old inflammatory trouble are seen to spread into the retina,

thus giving the nerve a woolly appearance. The vessels are usually much diminished in size, but not always. In some cases it is very difficult to be sure from the appearance whether the atrophy is primary or secondary. Other diseases leading to secondary atrophy are—embolism or thrombosis of the retinal artery or vein; atrophy following retinitis from any cause; tumours or bony growths pressing on the nerve; fracture of the base of the skull and any form of injury to the nerve in any part of its course.

Optic atrophy may occasionally follow extensive hæmorrhage, and perhaps hæmorrhage from the uterus is the most common. It has been seen to follow severe bleeding from a gastric, duodenal, or typhoid ulcer. Extreme anæmia from causes other than hæmorrhage may produce it, and it has been known to follow hæmorrhage into the optic nerve sheath from bad health or from injury. It may follow a neuro-retinitis due to Bright's disease or glycosuria.

Treatment.—Atrophy may be prevented in some cases of optic neuritis by decompression operations on the skull, and some people have opened the sheath of the optic nerve with the view of lowering the pressure in it, but without very markedly good results. The disease which is causing it must be treated, and if inflammatory symptoms still remain, leeches should be applied and full doses of mercury given. Strychnine may also be indicated. Whatever treatment be adopted, blindness is almost sure to follow sooner or later.

Tumours of the Optic Nerve are very rare, and are more often seen in young people than in old. They may be intradural or extradural. The former are generally neurofibromata, while the latter are usually myxosarcomata or myxofibromata, but their microscopic characters differ a good deal.

Symptoms.—The eyeball gradually becomes pushed forward, but in spite of this the movements are not restricted in any particular direction. The sight is lost or greatly impaired very early in the disease. Most of these growths

show no tendency to the formation of metastatic deposits, though they may spread back into the cranial cavity. The general health is not materially affected.

Treatment.—Probably the best thing to do is to remove the eye with the tumour, and if necessary exenterate the orbit. Krönlein's operation of removing the outer wall of the orbit and then excising optic nerve and tumour while

FIG. 76.—Opaque nerve fibres. (After Frost.)

leaving the blind eye has been done with success, but it is very doubtful whether there is much to be gained by this operation, considering the fact that it is not possible to remove the tumour so effectually, and in any case the eye without an optic nerve is not more useful than a glass one, and may not even be so ornamental.

Opaque Nerve Fibres.—A curious congenital appearance is not unfrequently seen, and is due to the optic nerve fibres not losing their medullary sheath, as is usually the case when they enter the eye, this produces the appearance

known as opaque nerve fibres, and must be carefully distinguished from atrophy of the choroid or disc. They may form patches of any size, and may appear in the retina closely connected with the disc at any part of it. Sometimes they completely surround the disc as is seen in Fig. 76. The vision of these eyes is usually quite good.

CHAPTER XIII

DISEASES OF THE ORBIT

THE orbit is the large bony cavity in which the eyeball is situated. It is far larger than the globe, and the remaining space is occupied by the lacrimal gland, the muscles nerves and blood-vessels supplying the eye and the adjacent structures, as well as by a large quantity of fat, which forms a cushion for the eye to rest upon.

Exophthalmos, or the pushing forward of the eyeball, is not a separate disease in itself, but is a very valuable symptom of many pathological conditions. Sometimes it is due to a growth or to some other local condition in the orbit, at other times it is a symptom of a general condition, such as Graves' disease. Care must be taken to make sure that exophthalmos really is present before stating positively that it is, for certain conditions of the eyelid give rise to a false appearance. Again, some eyes are naturally far more prominent than others. The size of the palpebral aperture gives a very erroneous idea of the size of the eye. If it be wide, and the whole of the cornea and some of the sclerotic above and below it be exposed, the eye looks very large and prominent, while it may really be no larger, and perhaps no more prominent, than an eye which appears to be small through its being deeply set and seen through a narrow palpebral aperture. A patient is often brought because one eye is supposed to be getting smaller, when all that is the matter is that the eyelid is swollen and the palpebral aperture is diminished. The best way to judge of the presence or absence of exophthalmos is to set the patient in a low chair, while the observer stands

behind and looks down upon the eyes from above. He can then judge of the relative position of the two eyes by seeing how much of the globe protrudes in front of the supraorbital ridge. It may sometimes be noticed in this way that the eye which looked proptosed is really deeper set than the other, which appeared normal, so great is the effect of the size of the palpebral aperture and the lids on the appearance of the eyeball.

Exophthalmos may be due to growths in the orbit, to abscesses, cellulitis, periostitis, tenonitis and panophthalmitis; to certain vascular lesions such as thrombosis of the cavernous sinus, arterio-venous aneurism and to hæmorrhage following a ruptured vessel. The most terrible proptosis is seen in cases of oxycephaly, in which practically no orbit exists. Suppuration in the antrum or the sphenoidal or ethmoidal sinuses may so diminish the size of the orbit as to produce proptosis. These cases are usually unilateral. The most common cause of a bilateral affection is Graves' disease, or exophthalmic goitre.

Enophthalmos, or a sinking inwards of the eyeball, is seen in severe emaciation, and in cases of paralysis of the cervical sympathetic. Blows and injuries of the head and eye may cause it on one or both sides, but usually on one side only. Some eyes are naturally very deeply set.

Cellulitis of the Orbit is due to an inflammation of its cellular and connective-tissue. Its most common cause is a penetrating wound; it may also follow erysipelas, and is sometimes due to the spreading of a lid abscess or to infection from one of the air sinuses in the immediate neighbourhood. It must never be forgotten that foreign bodies frequently get into the orbit without any visible external wound; in this way all sorts of things have been found in orbital abscesses—pieces of wood, twigs, the stem of a clay pipe, stones, small shot, etc. A man may fall into a hedge and a piece of a stick may easily enter the orbit through the fornix of the conjunctiva, break off short, and be entirely hidden. A thin cane or walking-stick has often been thrust

into an orbit in this way, and sometimes into the base of the brain as well, without being suspected, until, perhaps, the wound is found *post mortem.* A very common cause of abscess of the orbit is suppuration of the lacrimal gland. It may occur as the result of pyæmia or some other acute infective disease, such as mumps.

Symptoms.—The general symptoms of a cellulitis of the orbit are much the same as abscesses elsewhere, while the local symptoms are redness and swelling of the surrounding parts and proptosis with some degree of immobility of the eyeball. Ptosis is generally present owing to pressure on the third nerve, while the eye is sure to be displaced to a greater or less extent. If there be much displacement it is obvious to the observer, but if only slight the diplopia which is certain to be caused will announce its presence unless the sight is so interfered with that the second image is not noticed. There will probably be some discoloration of the lids, with œdema of the skin and chemosis of the conjunctiva. Sometimes a boggy swelling can be felt in the orbit, and if there is an abscess, distinct fluctuation may be felt; but if the abscess is far back this may not be apparent, so that treatment should never on this account be delayed. Tenonitis, or inflammation of Tenon's capsule, gives rise to much the same symptoms, and may end in suppuration or it may subside.

Prognosis.—Cellulitis and suppuration of the orbit are always serious matters. The danger is from meningitis, and this is very likely to occur unless a free incision be made so as to establish a good drain. Small incisions are almost useless; nothing is worse than to have a small fistulous opening extending deeply backwards into the orbit from which a certain amount of purulent discharge exudes. The drainage is inefficient, and the inflammation will probably extend backward and cause meningitis or a cerebral abscess. Most cases do well if prompt and efficient treatment be adopted; they mostly do badly if treatment is delayed or is inadequate. Besides the danger to life, there is a very real

danger to the sight, as the optic nerve may be so damaged that it will atrophy and cause blindness. A very troublesome diplopia may remain for a considerable time after the acute symptoms have subsided.

Treatment.—In the very early stages a mercurial purge with hot fomentations applied to the orbit may cause things to subside, but should this not be the case a free incision must be made into the inflamed orbit at once. The best place for the incision is, through the skin and between the roof of the orbit and the eyeball. When well into the orbital tissues a pair of sinus forceps may be passed backwards and opened so as, if possible, to enlarge the opening into the abscess cavity if there be one. There is really no chance of wounding the eyeball if care is exercised. The surgeon should never feel disappointed if he cannot find pus. Even if it is there, and he has missed it, the abscess is certain to open into the incision within a short time; and if there be no abscess, the incision is still the best treatment for the cellulitis. A drain is then placed in the incision and hot fomentations are applied. Should the cellulitis be due to a suppurating eyeball the offending globe should be at once excised, and by this means the greatest possible amount of drainage is obtained. Some surgeons fear excising a suppurating eye, thinking that meningitis may be caused; others, with far more reason, fear to keep an eye in this condition, being convinced that draining the abscess and getting rid of the pus is more likely to prevent infection than to produce it. The cause must be found out, and if it be due to a suppurating air sinus this must be treated accordingly.

Orbital Periostitis may be acute or chronic.

Acute Periostitis gives rise to all the symptoms of an acute abscess, but by being so intimately connected with the bone it is more serious and may cause necrosis of some part of the orbital wall. Should the roof of the orbit be affected a cerebral abscess is likely to be the result.

Chronic Periostitis is more often than not syphilitic, and

if it goes on a definite gumma may form in the orbit. Periostitis sometimes occurs as the result of rheumatism, or is a sequel to tubercular disease of the bone. There is usually great aching pain, and sometimes paralysis of some of the orbital muscles. If the optic nerve be involved it may become atrophied.

Treatment.—An incision should be made in the case of acute periostitis, which will probably be taken for one of orbital cellulitis, but bare bone may be met with, and this will determine the nature of the case. In chronic periostitis due to syphilis, iodide of potassium and mercurial inunction will probably soon cause it to subside. In the rheumatic and tubercular cases it must be treated on general principles.

Caries of the Orbit is frequently a result of periostitis, arising either through injury or more probably as the result of syphilis or tuberculosis. In tubercular children the orbital margins are usually affected, and sinuses and fistulæ lead down to bare bone. Often the bone in the region of the lacrimal sac and nasal duct is affected. In syphilis a gumma leading to necrosis and caries may occur at any part of the orbit, and so also may caries resulting from injury. Abscesses and suppurating tracts leading from the skin to the carious bone will frequently be found; and the contraction caused by it may produce distortion of the eyelids and surrounding parts.

Treatment.—If an abscess forms it should be opened at once and efficient drainage ensured. The bone and all tracts must be scraped, and everything done to promote healing. If sequestra are present they will have to be removed, and sometimes extensive operations must be undertaken in order to get them away. In any case much scarring and disfigurement will take place, and there is a certain amount of danger to the eye as well.

Injuries of the Orbit.—These may be due to penetrating wounds or to injuries from large objects which do not cause an actual wound. The least important orbital injuries are due to blows with a fist, in which a subcutaneous ecchymosis

is produced, which at first leads to swelling and discoloration of the lids and then it gradually becomes absorbed without further trouble. If the blow is more severe a considerable amount of bleeding may occur in the orbit, and this, besides causing greater disfigurement, may lead to blindness from injury to the optic nerve. This is especially likely to happen if there has been a fracture about the optic foramen.

Intense and deep ecchymosis of the eyeball, with or without obvious hæmorrhage into the orbit, is an important sign of fracture of the base of the skull. Penetrating injuries may cause orbital abscesses and cellulitis as previously described, while it is not very uncommon to find an optic nerve cut across by a bullet which may have been fired with suicidal intent; both optic nerves have in this way been known to be cut without producing any effect other than absolute blindness. Frequently an injury produces paralysis of one or more ocular muscles.

Air may be forced into the orbital tissues through a fracture communicating with one of the nasal sinuses; this gives rise to surgical emphysema and produces the curious and characteristic crepitations felt when air is beneath the skin.

Treatment.—The treatment of injuries to the orbit is obvious in most cases, and depends in great measure on the extent of the damage. Nothing need be done to the simple ecchymosis more than applying an evaporating lotion. If the hæmorrhage be extensive, hot fomentations are better than cold after the first day or so. Should there be a foreign body in the orbit it must be removed, and if the wound be infected, antiseptics and hot fomentations must be applied. For the more severe injuries rest in bed for several days or weeks is essential.

Thrombosis of the Cavernous Sinus produces so many signs in the orbit that it may be included in this chapter. When the close proximity of the oculo-motor nerves to the sinus is considered, it is easy to see that a serious condition like this is almost certain to affect them. One of the early

symptoms is paralysis of the third, fourth and sixth nerves. These need not of necessity all be affected, but they probably will be after a time. It is very probable that the fifth nerve and optic nerve will also be involved, and if this is so every nerve supplying the eye is affected, so that there is neither sight, motion nor sensation left. Although at first, owing to irritation of the third nerve, the pupil may be contracted, when paralysis sets in it will be semi-dilated and inactive.

There are usually severe general symptoms—pyrexia, vomiting and rigors; both sinuses are generally affected. Thrombosis of the internal jugulars is frequently present as well.

Causes.—The usual cause of thrombosis of the cavernous sinus is middle-ear disease, with extension of a septic clot from the veins draining the mastoid process when that bone is involved in the suppurating process. It may follow any general septic condition, or septic thrombosis in any other vein communicating with the sinus. Optic neuritis is not always present, but it mostly is in severe cases. Among local causes are erysipelas and infective diseases of the mouth, nose, throat, orbit, etc.

Prognosis.—This is necessarily very bad, and the cases usually end fatally from septicæmia or pyæmia.

Treatment.—There is very little to be done for this condition. Vaccine treatment may be tried, and the disease which has caused the thrombosis must be treated. Ligature of the internal jugular vein has been done with the idea of preventing the septic thrombus from getting into the large thoracic veins.

Inflammation, or Suppuration, of the Accessory Nasal Sinuses.—A mucocele or empyæma of the air sinuses about the orbit may cause swelling and encroachment of the walls into the orbit, and in this way simulate a new growth. The air spaces chiefly involved are the frontal, ethmoidal and sphenoidal sinuses, and the antrum.

Mucocele of the Frontal Sinus.—The sinus, being practically non-existent before about the seventh or eighth

year, is of no account in children below that age. Later on the mucous membrane lining it may become acutely inflamed, as is so frequently the case with an ordinary cold in the head, or it may become chronically inflamed and thickened, leading to the retention of much glairy fluid. This causes distension of the bone, and very likely displacement of the eyeball. Should suppuration occur, it may burst into the orbit and form an orbital abscess.

Mucocele of the Ethmoidal Sinuses causes a bulging of the inner wall of the orbit, with displacement outwards of the eyeball. There is often some displacement of the eyelid, giving rise to epiphora. The abscess may burst into the orbit, and there are usually some nasal symptoms.

Suppuration, or Mucocele, of the Antrum of Highmore is generally caused by infection from the root of a tooth, but it may become infected from the nasal cavity. If it encroaches on the orbit the floor will be raised and the eyeball displaced upwards. The abscess may burst into the orbit, and on opening it a tract will be found extending into the antrum. It may discharge into the nasal cavity.

Suppuration of the Sphenoidal Sinuses may lead to an abscess bursting into the orbit, but it is very rare.

Treatment.—Very little need be said here regarding the treatment of these suppurating sinuses, as they essentially belong to the domain of nasal surgery. The pus has to be evacuated and the mucous membrane removed or scraped.

Tumours of the Orbit.—The orbit contains so many different structures that it is difficult to classify the tumours which are met with. They may be divided into two large groups, viz. innocent and malignant.

The *non-malignant* tumours consist of dermoids, meningoceles, serous and parasitic cysts, usually hydatids and cysticercus, exostoses, angiomata, fibromata and gummata; distended frontal and ethmoidal sinuses and distension of the maxillary antrum; also lymphomata and lympho-adenomata—these latter being often symmetrical in each orbit.

The *malignant* tumours are sarcomata, carcinomata, endotheliomata, neuromata, neuro-sarcomata and lympho-sarcomata.

Symptoms.—All orbital tumours give rise to much the same symptoms in their early stages. Usually the first thing noticed is some displacement of the eyeball, and the attention of the patient may be directed to it in a very early stage by the development of diplopia. Should the growth be situated anywhere but immediately behind the globe (such as occurs in tumours of the optic nerve), the eye will be displaced away from it as well as forwards, while in optic-nerve tumours no lateral displacement is as a rule visible. According to the rate of the growth so will the displacement alter in amount. The sight will be affected in a very variable manner. In tumours of the optic nerve the eye is usually blinded very early in the disease, but if the growth is away from the nerve it may attain a large size before the sight is affected. Very vascular growths and aneurisms often give a sense of pulsation, and a bruit may be heard on applying a stethoscope over the eye or orbit. In such conditions as cellulitis of the orbit and in Graves' disease, where there may be great proptosis, other signs readily distinguish it from a new growth. Frequently the tumour can be felt with the finger; and cysts and abscesses will give rise to fluctuation if they are far enough forward. The occurrence of pain is variable and depends upon local conditions. The movements of the eyeball are important to watch. A tumour pressing on one side of the globe may prevent its being rotated to that side, either because of the pressure of the growth itself, or on account of the involvement of the muscle or motor-nerve supplying it. A growth directly behind the globe may produce considerable proptosis without limiting the movement in any particular direction. Should the proptosis be very great the cornea may suffer from exposure on account of the eyelids not covering it.

Cysts.—Whenever a cystic tumour is discovered in the orbit the fact that it might be meningocele or a hernia

cerebri must never be forgotten. Such protrusions usually occur at the fronto-ethmoidal suture. These tumours may or may not pulsate.

In a curious congenital condition in which only the barest rudiment of the eye is present a cyst containing serous fluid with the retina inside it is sometimes found in the orbit; but the cyst is not the altered eyeball, but is connected with the rudimentary globe, which may be extremely small.

Parasitic Cysts are not common in this country, but they occasionally occur; they are nearly always hydatids, while the echinococcus has been found.

Treatment.—A meningocele or encephalocele or hernia cerebri had better be left alone, or if it is interfered with the greatest care must be taken to prevent sepsis, which would of course lead to fatal meningitis. The other cysts may be removed by dissection, and in the case of hydatids they will sometimes push their way out as soon as an opening is made. Sometimes the walls are adherent, and require to be dissected out as thoroughly as possible by an incision above or below the eyeball, or by Krönlein's method, which consists of turning down the outer wall of the bony orbit and replacing it before closing the wound.

Non-malignant Solid Tumours, such as exostoses, angiomata and fibromata, vary so much in character that there is but little difficulty in making the diagnosis between them. Exostoses grow usually from the upper or inner wall of the orbit. They are often as hard as ivory, and so dense that it is almost impossible to drill them, especially if the base be broad; if pedunculated they may be drilled through and sawn or cut off with bone forceps. Great care must be taken, if they grow from the frontal bone, for fear of causing a fracture into the cranial cavity. They cause the most horrible disfigurement, and may press on the eyeball sufficiently to destroy it. They are sometimes composed of cancellous bone, and then they are more easily dealt with. These cases are fortunately rare. Angiomata of the orbit had better be left alone, while fibromata may be

removed through the front of the orbit or by Krönlein's method at the outer side. Gummata will absorb by giving mercury and iodide of potassium.

Malignant Growths of the Orbit are usually sarcomata or endotheliomata; the latter arise from the endothelium of the vessels, and the former from any connective tissue structure in the orbit. They are frequently subperiosteal, or may arise from the lacrimal gland. A glandular carcinoma may also arise from the lacrimal gland. Metastatic carcinoma may occur in the orbit, usually from cancer of the breast, while a sarcoma of the choroid may burst through the eyeball and involve the orbit.

Treatment.—The tumour, the eyeball, and the rest of the contents of the orbit had better be entirely exenterated, as this gives the patient the only possible chance of life. Should it be decided to do this, the margins of the lids, including all the eyelashes and every trace of conjunctiva, should be removed as well. If this be done the skin falls in and completely lines the orbit, while if the lashes and some conjunctiva be left there is always a more or less unhealed and discharging gap left at the bottom of the deep cavity. Some of these cases do extremely well after thorough evisceration. It is seldom necessary to graft or do any plastic operation. Metastatic growths had better be left alone, as their removal will do no good.

Pulsating Exophthalmos is usually due to an arteriovenous aneurism, and may result from an injury or spontaneously. A bruit is mostly to be heard, and this may sometimes be stopped by pressure on the common carotid. There is generally great venous congestion of the eye and orbit, while the roaring noise is a source of considerable discomfort to the patient.

Treatment.—Several cases have been cured by ligature of the common carotid artery as well as by digital compression. Occasionally they cure themselves spontaneously.

Intermittent Exophthalmos is a curious condition due to a nævus or to distended veins at the back of the orbit.

When the patient is upright the eye on the affected side is more deeply set than its fellow; but directly he stoops, or compresses the veins of his neck, the eyeball comes forward and protrudes considerably. No treatment is possible.

Malignant Growths of the Lacrimal Gland, either sarcomata or carcinomata, must be treated by excision, just as other cases of malignant growths in the orbit.

Tumours of the Optic Nerve are described under diseases of the Optic Nerve, p. 215.

CHAPTER XIV

GLAUCOMA

The essential feature of glaucoma is an increase of tension of the eyeball. The disease is divided into two large groups, Primary and Secondary. Primary glaucoma is a disease of itself, while secondary glaucoma is dependent upon some other morbid process in the eye, and will be dealt with when speaking of the conditions which cause it.

Primary Glaucoma.—This disease presents itself clinically in two very distinct forms—(*a*) Acute, and (*b*) Chronic.

Acute Glaucoma is frequently termed inflammatory, congestive, fulminating, or malignant, according to the degree of acuteness which the symptoms present, but the characteristics are the same. The tension may rise suddenly in an eye and may in an hour or so be raised to such a pitch that it assumes a condition of stony hardness. When this happens it causes acute pain, intense congestion of the eyeball, and more often than not vomiting. The pain is not only confined to the eyeball, but radiates around the orbit and side of the nose, while it is so acute at times that it is no exaggeration to call it agony. Still it varies much in its intensity, and it sometimes happens that because the patient complains of headache and vomiting, the practitioner who is not well acquainted with eye diseases mistakes it for a gastric attack, and treats it accordingly.

Should such a mistake occur it is fatal to the eyesight, for unless the tension be relieved in a short time it produces such profound changes in the retina that it altogether fails to recover even when the eye becomes soft. All the while the gastric symptoms are being treated the cause of the

disease may be left untouched, and by the time these have subsided the vision may have disappeared entirely or in part. On examination the true nature of the disease should be at once recognized. The eye is suffused and injected, the conjunctiva may be chemotic. The cornea is always hazy and the pupil widely dilated. Vision will probably be reduced to counting of fingers, hand movement, or perception of light only, while in the worst cases the patient will not even have light perception. Although both eyes may be affected it very often happens that one only is in this acute

Fig. 77.—Method of testing tension of an eyeball.

condition, and consequently the patient may be unaware that there is much wrong with the sight; but it will always become apparent if the good eye be closed.

On ophthalmoscopic examination a dull reflex only is seen, and no details of the fundus are visible in spite of the widely dilated pupil.

The simplest way to test the tension is to make the patient look down, and with the middle or forefinger of each hand pressure is made alternately on the globe, just as if one were feeling for fluctuation. After some practice the tension thus felt with the finger will be readily recognized, and should any doubt remain there is usually the other eye for comparison, and if not the feeling of the normal eye of another

person will be quite sufficient to enable even the unpractised finger to detect the difference.

It is usual to record degrees of tension by using the plus and minus signs. If the tension is increased slightly T+ will indicate it, if more T + 1, more still T + 2, and when the eye is like a stone T + 3. The minus signs are used in exactly the same way to indicate diminished tension, T − 3 being the condition of an eye which is collapsed and very soft indeed, and T − means a little softer than normal; T*n* indicates normal tension.

Symptoms such as above described, usually come on in persons of middle age or above, and are very rare in any one below thirty years. Generally as a predisposing cause, something has happened to cause congestion of the head and neck, such as violent excitement or emotion.

Chronic Glaucoma presents a totally different set of symptoms. Both eyes are usually affected, though one may be more advanced than the other, while most of the symptoms which are so characteristic of acute glaucoma are absent in the chronic variety. Often the first symptom a patient complains of is some defect of vision. At night-time coloured rings like a rainbow are seen around a street lamp or candle, while a room in which a patient may be sitting will appear to be full of fog or smoke, and the vision will be considerably diminished. After a while these symptoms clear away and the sight to all appearance is as good as it was before. Should this go on for any length of time, the attacks become more frequent, and gradually the sight will fail. On account of his vision not being quite so good, he will be frequently blaming his spectacles. If now he consults an optician he will probably get them changed as often as he goes to him. While the sight is gradually getting less, the disease is advancing, and the time which is being wasted can never be regained.

In this way it differs markedly from acute glaucoma, when the patient may be practically blind, yet if an operation be undertaken within a few hours of the onset of the

symptoms the sight may be almost perfectly restored. In chronic glaucoma, it should be remembered that no matter how successful the operation may be, it is impossible to restore the sight to a better condition than it was when the operation was undertaken, the best that can be hoped for is that the sight which the patient still has shall be retained.

The extreme importance of the early recognition of the disease cannot be too strongly insisted upon. As in acute glaucoma, the anterior chamber is nearly always shallow, and sometimes so shallow that the anterior surface of the iris and the posterior surface of the cornea are almost in contact.

Pathology.—As to the cause of glaucoma, the main facts are undoubted, though authorities differ as to some of the minute details. Without entering deeply into this matter, which is altogether beyond the scope of this work, one may say that it is caused by a blocking of the channels of exit of fluid from the eyeball, while the inlet of fluid is unaffected; thus it is apparent that if the channels of exit are partially closed, the same amount of fluid can only be got out of the eyeball by increasing the pressure under which it is placed. If this diminution of the size of the channels of exit takes place very slowly, the tension is raised so gradually that no pain or other symptoms are produced. There is no congestion of the eyeball, little or no pain, and were it not for the fact that a little extra congestion takes place now and again, producing a mild sort of subacute attack, the vision will fail so gradually that there is nothing to call the attention of an unobservant man or woman to it, and the sight may be completely lost in one eye all unknown to the patient until the second eye becomes affected in a similar manner. On the other hand, if the blocking of the channels of exit takes place rapidly, the tension at once rises considerably, accompanied with inflammatory changes and acute pain. Although the symptoms are so different, yet the cause is the same, and it is purely a matter of the degree of rapidity with

which the blocking takes place. An eye suffering from chronic glaucoma may be as hard as any acute case, yet the former will be painless and quite white, while the latter will be acutely congested and very painful.

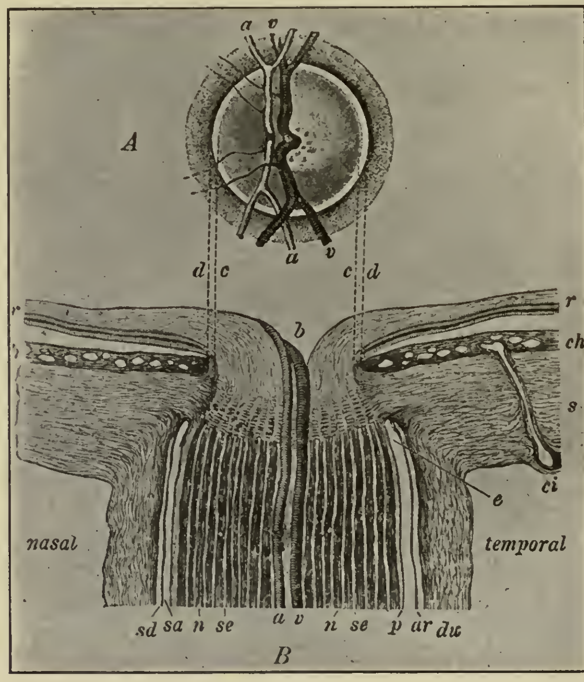


FIG. 78.—Normal disc. *A*, seen with ophthalmoscope; *B*, seen in section.

Fluid finds its way out of the eyeball through the angle of the anterior chamber—that is, the space which exists between the root of the iris and the cornea. In health this is sufficiently large to allow of the proper quantity of fluid passing out in a given time and with normal intraocular tension. If now the iris be pushed forward and the angle becomes diminished, it will be impossible for this state of affairs to balance, and as the same amount of fluid comes into the eye, so the tension must increase before it is able to

pass out again. It thus happens that if an eye which has increased tension be examined pathologically, the anterior chamber is invariably found to be shallow and the angle much diminished in size, though it must be remembered that the angle of the anterior chamber may become narrow with a deep chamber, but this is only seen in secondary glaucoma.

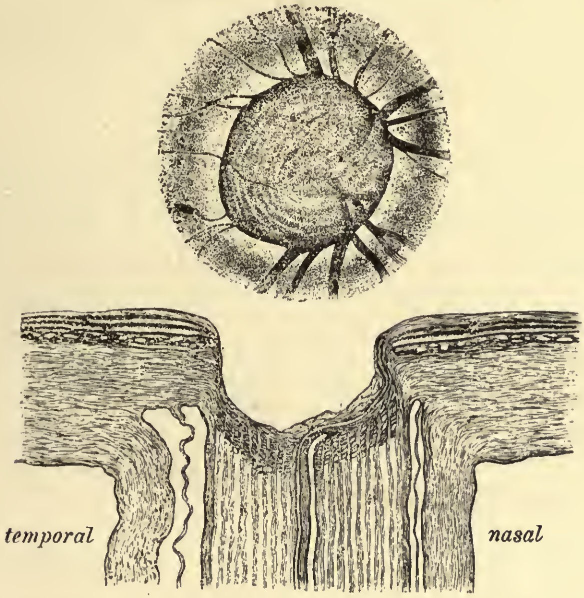


Fig. 79.—Longitudinal section through papilla with glaucomatous excavation showing cause of ophthalmoscopic appearances. (After Fuchs.)

If increased tension be allowed to remain for any length of time, not only does it destroy the sight, but it produces profound changes in the optic nerve, and the most obvious is the cupping of the head of the nerve which can be seen with the ophthalmoscope. This is called glaucomatous cupping in contradistinction to the physiological cupping which is frequently seen in health, and is a congenital condition and of no pathological significance.

The nerve quickly becomes atrophied and the sight is lost.

The field of vision is diminished in a characteristic manner. The nasal field always goes first, and so we see here considerable contraction on this side, while the temporal field remains full, or at least very much larger than the other side: Sometimes there is a sector only lost, and this may run in almost or quite up to the fixation point. The size and appearance of the field of vision as taken with the perimeter has a vast influence on the prognosis, and it should never fail to be mapped out.

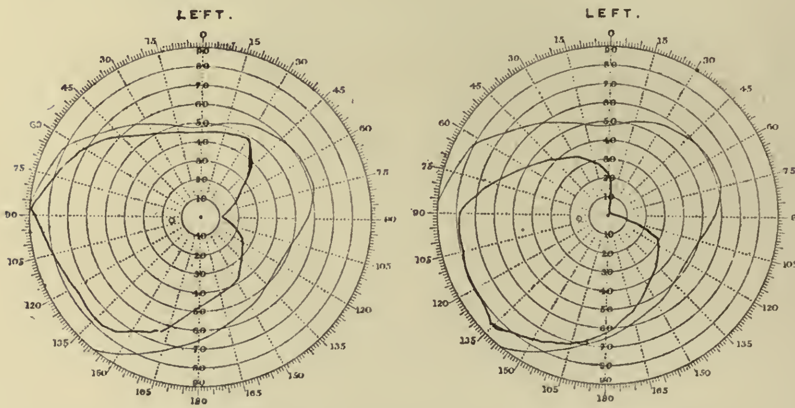


FIG. 80.—Field of vision in glaucoma, the outer line shows the normal limit of the field and the inner line shows the field in two typical cases of glaucoma.

There is, however, an earlier symptom by means of which a diagnosis may be made, and that is by accurately mapping out the blind spot. In early cases of glaucoma this is always considerably enlarged, and a very convenient instrument for doing this is the Bardsley scotometer or the perimeter (Figs. 11, 12 and 13).

Treatment.—This may be either medical or surgical. It will be noticed when speaking of the pathological condition necessary to produce glaucoma, that the angle of the anterior chamber is much diminished in size, and if this is so it is manifest that if the iris is crowded back into the already diminished angle, as occurs with a dilated pupil, it will serve

to block it still more; therefore in order to open it the pupil must be made to contract, and for this purpose myotics such as eserine and pilocarpine are of great value. If the eye be not too injected these drugs will be absorbed and will act, but should the congestion be great they will have but little effect. It has previously been stated that in glaucoma the pupil is dilated in most instances, and in an eye predisposed to glaucoma, or in the early stage of the disease in its chronic form, anything which causes dilatation of the pupil may bring on an acute attack, therefore mydriatics

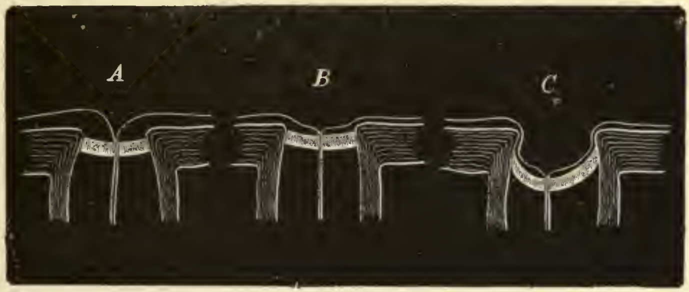


Fig. 81.—Diagrammatic representation of the different forms of excavation. *A*, physiological cupping of disc; *B*, atrophic cupping of disc; *C*, glaucomatous cupping of disc. (After Fuchs.)

must be avoided. Atropine and such-like drugs which dilate the pupil are sure to bring about an acute attack, but so insidious is the disease in its early stages that no external symptom may be present, but no sooner is the pupil dilated than the tension rises. This is the great danger in using mydriatics in people above middle age. For refraction purposes it is never required, but should a mydriatic effect be necessary, the eye should first be examined, so that glaucoma cup may at least be seen if such exists. Nothing is more common than for a person suffering from chronic glaucoma to come complaining of symptoms of presbyopia only; now if such an eye be treated with a mydriatic, acute tension is sure to develop. It is frequently claimed for some new mydriatic that it will dilate the pupil without

raising the tension. Such a statement only shows the ignorance of the person making it. It matters nothing how the pupil is dilated, the tension will rise if the local conditions favourable for the development of glaucoma exist. Such drugs as homatropine, euphthalmine, cocaine, etc., are only less dangerous than atropine because their mydriatic properties are less and last for a shorter time;

FIG. 82.—Physiological cup.

consequently myotics can act more quickly and more powerfully the weaker the drug is they have to counteract, but to say that all pupils may be safely dilated with a certain drug is absurd. No harm will be done to a patient by dilating his pupil if his eye be normal, no matter how old he is, and no eye which is in a glaucomatous state will allow the pupil to be dilated without serious results ensuing. So much confusion on this point exists that the true state of affairs must be insisted upon.

Most cases of acute glaucoma occur at night-time or in the evening for two reasons: first of all because the patient

is usually tired and there is probably some congestion of the head and neck; and secondly, because darkness favours the dilatation of the pupil. Having thus explained the theory of the case the actual treatment is obvious, viz. that the angle of the anterior chamber must be opened in some way or other. Immediately the case is seen eserine of any strength from one-sixteenth to four grains to the ounce must be instilled. It is well not to use a stronger solution than necessary, as it causes pain, and sometimes very acute pain, and if the desired effect can be obtained by milder solutions, so much the better. Pilocarpine has a weaker action than eserine.

Although a case of glaucoma may be kept quiet while more or less under control of myotics for a considerable length of time, yet they will never cure the disease. Nothing is more brilliant than the effect of a successful iridectomy in acute glaucoma, but in the chronic cases things are very different. Since the days of Von Graefe, who was the first to point out the beneficial effect of iridectomy in this disease, the operation has until quite recently been held to be the only one of any real value, but lately, owing to the researches of Le Grange, Herbert, Elliott, Freeland Fergus and others, several new operations have been introduced. It is obvious that the only way out of the difficulty is to open up the original exits of fluid in the eye or else to provide others. Now iridectomy aims at opening up the angle of the anterior chamber, and for this purpose the iris must be removed right up to its root; while the various forms of sclerotomy and sclerectomy which constitute the newer operations aim at providing a scar through which fluid may filter into the subconjunctival tissues.

Space does not permit us here to go into the technical details of the various operations, but they may all be read in the original papers in which they are described, and most of them appeared in the *Transactions of the Ophthalmological Society*. These operations are so very technical that unless a surgeon has had special opportunities of study and

practice, it is scarcely worth while for him to operate if he is able to call in an expert to do it for him.

Iridectomy for Acute Glaucoma.—This is still the most reliable operation to perform in acute glaucoma. On account of the difficulty in getting a local anæsthetic to act in an inflamed eye, it is far better to use a general anæsthetic.

In order to do the operation successfully a peripheral incision must be made, and it is far safer to make it with a Graefe knife. The wound should not exceed in length a quarter of the circumference of the cornea and should have a conjunctival flap attached to it. Iris forceps are then inserted, and the iris is caught rather nearer the periphery than the pupil. It is then withdrawn until the pupillary edge is seen to be outside, and a snip is made with the scissors into it. Then the iris is torn from right to left for the full extent of the incision. It is disentangled from the extreme edge by bringing the forceps back again a short distance, and cut off as close to the cornea as possible. The cut edges are then replaced and the conjunctival flap is laid neatly over the wound.

Secondary Glaucoma is an increase of tension following the closure of the angle of the anterior chamber due to some other disease of the eye. The following conditions may cause it—

(*a*) Perforating wounds and ulcers of the cornea, leading to an adhesion or incarceration of the iris in the wound, thus dragging the iris forwards; and closing of the angle of the anterior chamber.

(*b*) Total posterior synechia, in which the anterior and posterior chambers are completely isolated the one from the other; the result is that fluid can get behind the iris, but is unable to pass through the pupil, and so into the filtration angle of the anterior chamber. The result of this is to increase the tension in the posterior chamber, and to bulge forwards the unattached portion of the iris which is situated between the adherent pupil and the rest of the iris, thus

causing the condition known as *bombé* iris. This in turn narrows the angle of the anterior chamber, and increased tension is the result. An iridectomy is the only cure for this (Fig. 83).

(*c*) The lens being displaced laterally, or into the anterior chamber, is almost sure to cause some blocking of the angle with increased tension. The lens has to be removed, but let no one undertake it with the idea that the operation will be simple, it is usually very much the reverse.

(*d*) After injury to the lens, either from accident or from

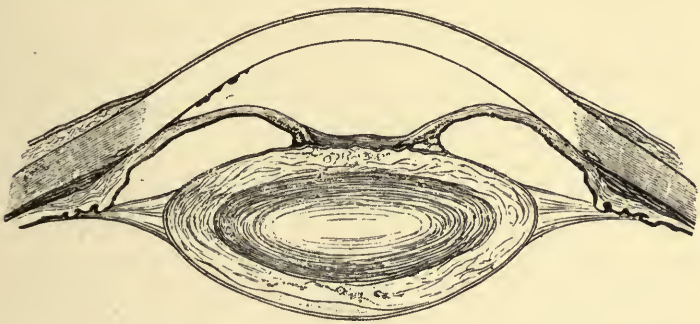


Fig. 83.—Total posterior synechiæ with blocked pupil and iris *bombé*.

the needling of a cataract, it will sometimes quickly swell and become disorganized; this also may cause increased tension, for the same reason as explained in the last paragraph. It is sometimes seen to follow the needling of a capsule secondary to the extraction of a cataract.

(*e*) In serous iridocyclitis the tension is frequently raised, and usually with a deep anterior chamber, but even here the angle will be much narrower or perhaps closed altogether.

(*f*) Intraocular tumours not infrequently give rise to increased tension, but again it is due to narrowing or closure of the angle of the anterior chamber, and not to the size of the tumours directly.

(*g*) Buphthalmos, or congenital hydrophthalmos, is really a variety of iridocyclitis which has occurred in a very young

eye. The coats being unable to stand the increased pressure bulge and stretch and produce the very large and blind eyes seen in this disease.

Treatment.—In most cases an iridectomy is the proper treatment. If disorganized lens matter be present it should be let out as described under the treatment of traumatic cataract. Eserine is scarcely ever required; atropine must be used in all cases of iridocyclitis, and if the tension still remains high paracentesis or sclerotomy had better be done.

CHAPTER XV

SYMPATHETIC IRRITATION AND OPHTHALMITIS

The close association of one eye with the other is well known by every one. It is common enough to get irritation of one by a trivial condition of the other, such, for instance, when the one eye waters because a foreign body has got into the other. This is a purely reflex phenomenon and never leads to anything serious, while it stops as soon as the exciting cause is removed. This is the simplest form of sympathetic irritation. It occurs, however, in other and more serious conditions, such, for instance, as when a healthy eye is irritated by a shrunken and inflamed globe on the other side. This may then give rise to considerable anxiety, for if an eye is sufficiently injured to produce such an effect, it is quite likely that sympathetic ophthalmitis may follow. Still the one must not be looked upon as a precursor of the other. Sympathetic irritation may exist for years without causing any structural lesion in the eye; and in some of the worst cases of sympathetic ophthalmitis it is frequently not present at any time. The two conditions are so far distinct, but the presence or absence of the one must not be taken as indicating the other will or will not develop.

Treatment.—If the injured eye be irritable, and not worth saving, the sooner it is excised the better. It will at once cure the condition, and will at the same time prevent the development of sympathetic ophthalmitis. If an injured eye heals up and is entirely free from irritation, so also will the other be, but it is never worth risking the sight in the

only eye for the sake of keeping a remnant of an eye which is blind and useless.

Sympathetic Ophthalmitis.—This is perhaps the most serious disease to which the eye is subject, and it is also somewhat mysterious, for we do not know for certain how it is produced, neither can we in any case of wounded eye say that it will or will not develop.

There are certain conditions which must be fulfilled before it is justifiable to use the term. For instance, it is quite wrong to say that because one eye has cataract or glaucoma or iritis, and the other gets it too, that therefore the one caused the other; the fact is, that what caused it in the first eye also brought it about in the other.

It may be held as an axiom that there is no such thing as sympathetic ophthalmitis apart from a penetrating injury. The injured eye may be termed the exciting, and the other the sympathizing eye.

The disease is essentially a plastic uveïtis, and unless this state of things be present in the injured eye it cannot transmit it to its fellow.

A few facts are known about the disease, and some of them are hard to explain. It is always caused by either a penetrating wound or a perforated ulcer, and any eye which has once been opened by operation, accident or disease, may cause it to develop in the other.

The injured eye is affected with a uveïtis, and by some means or other it gets transferred to the sympathizing eye. Although it is probably a micro-organism which causes it, yet it has never been identified or recognized. The position of the wound seems to have some effect, as many more cases are seen after an injury to the ciliary body and iris than if those structure have escaped; this, however, may be due to the fact that a dangerous uveïtis is far more readily produced if these parts are injured.

If it were due to a septic micro-organism we should expect that the greater the number of these there happen to be the greater would be the chance of sympathetic ophthalmitis

developing. So far from this being the case, the fact is that a suppurative panophthalmitis never or hardly ever produces the disease, while a quiet, innocent, clean-looking wound, especially in the ciliary region, is the sort of injury which will be most likely to produce it. Again, a foreign body which is to all appearance causing but little irritation may produce it, but if it causes the first eye to suppurate it scarcely ever does so. Many a case has developed after cataract extraction followed by iritis, perhaps of a mild type, but not if the eye suppurates. The latter may produce a shrunken globe and that may cause the disease, but long after the acute inflammation has subsided. Recent research and examination of the blood suggests that it may be a protozoon disease.

Some cases have been recorded in which there has been a sarcoma in one eye followed by sympathetic inflammation in the other. This is easy enough to explain if the growth has perforated the eyeball, and although it has been stated to have occurred without perforation, yet it is extremely difficult to make sure that at some spot or other the eye has not really been opened sufficiently to allow of the organism to enter, if indeed such really is the cause of the disease.

If the optic nerve were the tract by which the inflammation travelled we should expect that optic neuritis would be the first sign. This has often been stated to be the case, but it is open to much doubt. As a rule keratitis punctata and serous cyclitis are the first signs, and this causes the media to become hazy. Now if the disc be looked at through hazy media it has very much the appearance of an early neuritis. On the whole one can only say that although most things point to its being a direct infection by micro-organism, yet no proof has ever been forthcoming, and many of the symptoms and facts are hard to explain on this theory. The protozoon theory has some things to recommend it, but it cannot at present be taken as proved.

A very important question to decide is this : How long may an eye which is dangerously wounded be left in order to see whether it will be worth saving ? This is most difficult to answer. It may safely be said that sympathetic ophthalmitis is hardly ever seen to develop under three weeks after the original injury, and this is generally taken as being about the limit of safety, and may be used as a working rule. At least one case has been seen in which sympathetic ophthalmitis started within eight days of the injury, but such is altogether exceptional. If, however, three weeks have elapsed and the eye is still irritable and dangerous-looking, and shows but little sign of improvement it is unwise to leave it any longer; it should then be excised. If fresh attacks of inflammation take place in an old injured eye, sympathetic inflammation may develop any number of years after the original injury.

Symptoms.—At any time after about three weeks the disease may start. There may or may not have been signs of sympathetic irritation. The first thing noticed is that the uninjured eye shows some sign of being a little irritable, and on examining it there is found to be a tendency to lacrimation, and perhaps some photophobia or a faint ciliary blush. With the oblique light and the corneal loupe some dots of keratitis punctata may be visible, the anterior chamber may be slightly deeper, and the iris commencing to look a little muddy. There are, in fact, all the signs of an early serous cyclitis. The iritis very quickly becomes more marked, and the pupil shows evident signs of getting bound down. The serous cyclitis has changed to a plastic one, and unless atropine be promptly used, the synechiæ will have become so firm that the pupil will not dilate. Every symptom that is possible in a severe plastic irido-cyclitis will develop. In spite of the most vigorous use of atropine the pupil becomes closed with lymph; the iris becomes *bombé,* the tension rises, and secondary glaucoma develops with a shallow anterior chamber. After a time the periphery of the iris becomes retracted and the anterior

chamber deep. The exudation may be so plastic and cellular that a hypopyon forms. As the disease progresses more and more changes take place. The cornea becomes opaque and the lens cataractous; the sight, which has been getting worse and worse all the time, gradually fades away; and the eye, from being extremely hard at last shrinks and the condition of phthisis bulbi is produced. No more violent form of cyclitis is known than a bad case of sympathetic ophthalmitis, and it is rightly the most dreaded disease which has to be treated in the whole domain of ophthalmic surgery. It is not every case which runs such a severe course, but when once the disease has started it may be impossible to arrest it until the eye is totally and hopelessly blind. Milder cases may recover with more or less damage, and sometimes useful vision is preserved. Frequently, however, the inflammation spreads backwards as well as forwards, and choroiditis will reduce the vision very much, even though the anterior part of the eye be not so severely injured. Even in mild cases relapses are possible.

Prognosis.—This is always most serious, and although some sight may eventually be saved, yet in many cases blindness results. It is impossible to say for certain whether a given case will run a severe or a mild course, but a good prognosis should never be given in the early stages.

Treatment.—The treatment of sympathetic ophthalmitis is essentially preventive. If the damaged eye be removed soon enough the disease will not develop, but it must be remembered that even at the time the eye is removed it may have started, although it may not show itself until some days afterwards. However, if this be so the attack is seldom severe. When once the disease is manifest it is too late, and the eye is certain to be severely injured, no matter how prompt and how energetic the treatment may be.

The question then arises, what should be done. Each case must be carefully decided on its own merits. The following facts should be taken into consideration.

(1) Although excision of the injured eye will certainly prevent the occurrence of the disease if it be removed in time, it will not necessarily save the eye if once the disease has developed, and it may appear to have but little influence on the subsequent course, which may go on to blindness.

(2) Should there be any sight in the injured eye, or any prospect of there ever being any, it may happen that the sympathizing eye will become totally lost, and the exciting eye will be the only one which retains any vision.

(3) Although excision of the exciting eye may not save the sympathizing eye, yet in most cases it has a beneficial effect, and it may prevent the disease from running so severe a course.

(4) Should the exciting eye be blind, with no prospect of its ever having any useful vision, it should be excised at once.

(5) In no case can excision of the exciting eye act prejudicially on the sympathizing eye.

It will thus be seen how very difficult it sometimes is to act. It should certainly be taken as a working rule that the sympathizing eye stands a better chance if the other be excised at once. It is no use waiting to see how things develop, for it is certain that they will be bad enough; and it really amounts to this—that unless the injured eye is ever likely to become useful, the sooner it is removed the better, but it must always be remembered that it may eventually be the better eye of the two.

As regards treatment of the sympathizing eye, the great difficulty to deal with is the extremely plastic nature of the uveïtis. Everything in the eyes gets glued up and adherent. Atropine must be used with energy and regularity from the beginning, for if only the pupil can be kept open half the danger is removed. Very often, in spite of almost poisoning the patient with atropine (for much of it gets absorbed), the pupil gradually becomes smaller and smaller, and eventually blocked; so likewise this sticky exudate gets

into the angle of the anterior chamber, and the two together quickly raise the tension and the iris becomes *bombé*. This is just the condition in which iridectomy is indicated, but in this disease it must not be done, for if it be, a traumatic iritis will be added to that already existing, and it will be made worse than ever. If a coloboma were made it would close up again, and after a short time no trace of it would be left. Leeching, atropine, hot bathing and mercury internally is all that can be done, though a paracentesis or sclerotomy may temporarily relieve the tension. The great hope is that the iritis may subside, and when the eye has been white for six months or a year an iridectomy may do good and help to restore vision should any healthy retina be left, but what with tension and inflammatory exudation the chances are poor. The lens will in all probability be opaque, or at least be covered with a dense layer of lymph, and the cataract may have to be removed before there is a possibility of getting any sight back, while the chance of the eye withstanding so severe an operation is small. Subconjunctival injections of cyanide of mercury or saline solution are worth trying and may do good.

Recently, encouraging results have been obtained by injections of Salvarsan, and if the disease be eventually proved to be due to protozoon infection it may act like it does in syphilis by destroying the organism.

CHAPTER XVI

EXTRAOCULAR MUSCLES

THERE are six extraocular muscles, all of which are inserted into the eyeball and produce its movements. They are the **Superior, Internal, Inferior** and **External Recti,** and the **Superior** and **Inferior Obliques.** Owing to the origin of these muscles being close together about the optic foramen, their actions are not simple. From the anatomical relations it can be seen that the external rectus turns the eye directly outwards, and the internal rectus turns the eye directly inwards, both causing the eye to rotate about a vertical axis.

The superior and inferior recti, arising from the inner part of the back of the orbit, both pass outwards as well as forwards; so that although the superior rectus is mainly responsible for the upward movement of the eye, it rotates it somewhat inwards (like the internal rectus), and also gives to the vertical meridian of the cornea an inward torsion or wheel motion; by this is meant that the upper extremity or north pole of this meridian is inclined inwards and its lower extremity or south pole outwards. The inferior rectus is chiefly concerned with the downward rotation of the eyeball, but it also rotates it somewhat inwards (as does the internal rectus), and gives the north pole of the vertical meridian of the eyeball an outward inclination, or outward wheel motion.

The obliques act most powerfully in rotating the vertical meridian; the superior inclines the north pole of this meridian inwards, and produces wheel motion inwards; while the inferior oblique inclines it outwards and produces wheel motion outwards. They both rotate the eye out-

wards (like the external rectus), while the superior oblique rotates the eye downwards (acting with the inferior rectus), and the inferior oblique rotates the eye upwards (acting with the superior rectus). Thus it will be seen that the outer wheel motion and inward rotation of the superior and inferior recti are counteracted by the inner wheel motion and outward rotation of the obliques, so that direct upward movement is accomplished by the combined action of the superior rectus and inferior oblique, while direct downward movement is accomplished by the combined action of the inferior rectus and superior oblique.

It is important to remember the nerve supply of these muscles. The external rectus is supplied by the sixth nerve and the superior oblique by the fourth, while all the rest are supplied by the third.

The two eyes in health always move together, and it is impossible to move one eye without the other. Both may be moved up or both down, but one cannot be moved up while the other remains still or is moved downwards.

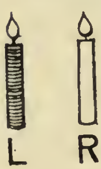
An internal and external rectus may act together to direct the eyes to the right or left, and both internal recti may act together to produce convergence, but both external recti cannot do more than bring the visual axes parallel after convergence; they cannot voluntarily act so as to produce divergence.

By the artificial aid of prisms these movements which are impossible under ordinary conditions may be produced to a limited extent. Should the visual axes not correspond diplopia will be produced. This may be caused by weakness of one or other muscle, or one eye may be pushed aside by an orbital growth. It is not always easy when looking at a patient with diplopia to say exactly what muscle is affected unless the muscle is so weak that an actual squint is produced. But it is possible by observing the position of the false image to make quite certain about this. It frequently happens with slight paresis of a muscle that the strong desire for binocular vision may enable a patient to overcome

the diplopia by an extra effort, but as soon as this effort is relaxed the eyes assume the wrong position and the diplopia returns. It is obvious, therefore, that every person who has a squint has also diplopia, but in those cases in which one eye has always been superior to the other, and binocular vision has never been developed, the patients themselves are unaware of it, and they mentally suppress the image seen with the defective eye. We are not here dealing with cases of concomitant squint, but simply with those which are produced by paresis or paralysis of one or other muscle. We will now consider the effect of paralysis of the individual muscles and the method of detecting them.

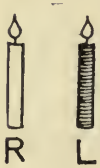
The patient is placed in a dark room, having a pair of trial frames on in which a red glass is placed in front of the affected eye. A lighted candle is held about five or six metres in front of the patient, who at once sees two images of the flame, one being red and the other its natural colour. Red glass in front of right or affected eye in all cases.

Paralysis of the External Rectus produces convergence. Here there would be true horizontal homonymous diplopia, and the images would be seen thus—

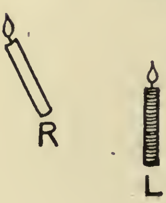


The images would become more separated as the candle was moved towards the affected side. The diplopia would vanish on moving the candle to the unaffected side.

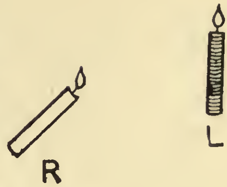
Paralysis of the Internal Rectus produces divergent squint; there will be true horizontal crossed diplopia. The separation would increase as the light was moved towards the unaffected side.



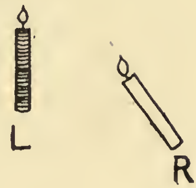
Paralysis of the Superior Rectus produces a downward displacement of the eye and gives rise to crossed diplopia, mainly vertical, the false image being higher and inclined away from the true; most marked in the upper field.



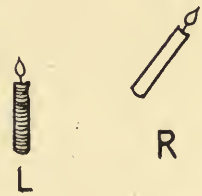
Paralysis of the Inferior Rectus produces an upward displacement of the eye and gives rise to a crossed diplopia, mainly vertical, the false image being lower and inclined towards the true; most marked in the lower field.



Paralysis of the Superior Oblique produces an upward displacement of the eyeball and gives rise to homonymous diplopia, mainly vertical, the false image being lower and inclined towards the true, and most marked in the lower field.



Paralysis of the Inferior Oblique produces a downward displacement of the eyeball and gives rise to homonymous diplopia, mainly vertical, the false image being higher and inclined away from the true, and most marked in the upper field.



It is quite unnecessary to try and remember these displacements but they can be worked out in a moment mentally if it be remembered that the false image occupies the same position as the affected muscle would give to the eyeball under normal conditions; thus in paralysis of the right external rectus, the false image will be to the right of the true, or again, in paralysis of the right internal rectus the false image will be to the left of the true, etc.

When testing a patient, care must be taken to see that he is not fixing with the eye which has the paralysed muscle, for if he does this the images will be reversed. It sometimes happens that a latent convergence or divergence may cause much confusion when testing eyes in this way, for it may transpose the images.

The measurement of the amount of displacement may be effected by means of the Maddox rod and tangent scale fitted on the wall, and also by means of the prism required to neutralize the diplopia.

Etiology of Ocular Paralysis.—Syphilis is by far the most common cause of this condition. It usually occurs as a tertiary manifestation due to a gumma or a thickening of the meninges or to some structure adjacent to the nerves in any part of their course. Tubercular or malignant growths may produce the same thing, while rheumatism and gout are possible causes. Fractures of the base of the skull are often followed by some paralysis; and the sixth nerve, owing to its long course, is more liable to injury than any other. Paralysis is frequently produced as the result of degeneration of the spinal or cerebral portions of the central nervous system, and the knowledge of the actual muscle affected is often of great localizing value.

Prognosis.—This depends very much upon the cause of the trouble. As a rule the syphilitic cases do well with vigorous treatment of the disease. The prognosis in tubercular, and especially in the malignant cases is extremely bad; so also is it in cases which are secondary to a degenerative lesion of the central nervous system. Those following an injury are often permanent.

Treatment.—The disease responsible for this trouble must be vigorously treated; if this happen to be syphilis, gout or rheumatism, good results are frequently obtained. Galvanism is sometimes employed with one electrode on the closed lid, and the other placed directly over the muscle, cocaine having previously been used. Prisms have but very limited use, for if they overcome the diplopia with the eyes in one position they will not do so in another. If the diplopia is extremely distressing to the patient the affected eye may be closed. Sometimes it is necessary to perform advancement of the weakened muscle, but this should not be done until many months have elapsed since the eye was first affected, for if the power of the muscle again returns the diplopia would be as bad or worse than ever.

Periodical Paralysis of the Third Nerve.—This curious condition sometimes develops in young people, and is characterized by the loss of function of the muscles

supplied by the third nerve. They are associated with severe headache on the side corresponding to the paralysed nerve, and often there is vomiting. These attacks come on at intervals of weeks, months or years, and the paralysis remains for a variable length of time. The prognosis is as a rule favourable, and the attacks tend to get less frequent, and finally cease altogether. The cause is unknown.

Treatment.—No special treatment is of any use. The general health of the patient should be carefully attended to.

Ophthalmoplegia Externa is that condition in which all the extraocular muscles are paralysed while the iris and ciliary muscle remains intact.

Ophthalmoplegia Interna is that condition in which the iris and ciliary muscle are paralysed, but the extraocular muscles retain their power. The paralysis of the internal and external muscles together is known as total ophthalmoplegia. Very often ptosis is not present even when all the other muscles are paralysed. The cause of this is usually a nuclear lesion, but it may result from a peripheral neuritis such as that due to alcohol. From a neurological point of view these cases are of great interest, but they cannot be fully gone into here.

Cerebral Paralysis.—These are due to lesions of the cortex cerebri, the corona radiata and internal capsule.

Paralysis of the Facial Nerve.—Besides the typical drawing of the face to one side, as occurs when one of the seventh nerves is paralysed, it produces the condition called lagophthalmos, or inability to close the eyelids. The condition and its treatment are described under "Diseases of the Eyelids."

Paralysis of the Iris and Ciliary Muscle has been mentioned above under the name of Ophthalmoplegia Interna, and may arise from some cerebral or nuclear cause. Besides this, it is produced by the action of certain drugs, such as atropine. It follows severe injuries to the ciliary nerves, and also concussion injuries to the eye, and certain orbital diseases such as necrosis of the bones, new growths,

etc. These lesions all cause dilatation of the pupil due to paralysis of the sphincter. If the cervical sympathetic is paralysed the pupil may become more contracted than usual, due to a paralysis of the dilator fibres.

Nystagmus may be congenital or acquired, and consists of rapid movements of the eyeballs, and is nearly always bilateral. Usually the movements are horizontal, but they are sometimes vertical or rotatory. Its presence is generally associated with some profound defect of sight, but even if this is not so, a rapidly moving eye cannot possibly have very good vision. It is most commonly congenital, and accompanies albinism and other congenital defects; it is also seen in eyes which have been badly damaged in infancy, *e. g.* by ophthalmia neonatorum, and in cases of congenital cataract. As an acquired affection it is seen in disseminated sclerosis and other affections of the central nervous system. A special form occurs in miners and others who work in constrained attitudes and with defective light. In the latter cases change of occupation may produce a cure, but there is nothing to be done in the way of treatment for the others.

Orthophoria.—Under normal conditions there is perfect balance of the ocular muscles in the two eyes, and when one alters its position the other makes a corresponding movement, so that the eyes are always directed on the object which is being looked at without any special effort. This condition is called Orthophoria.

Heterophoria, or Latent Squint.—It sometimes happens that when the eyes are at rest there is a tendency for one to assume a wrong position, and this is maintained even when they are directed upon a certain object; the obvious result of this would be diplopia. However, by practice such persons are able to exert a greater effort in one eye than in the other and so correct it; the result is that a squint does not appear, and there is no complaint of diplopia unless the eyes are unusually fatigued. This condition is called Heterophoria, or Latent Squint.

There are various forms of heterophoria, viz.—

Exophoria, where the eyes tend to diverge.
Esophoria, where the eyes tend to converge.
Hyperphoria, where one eye is directed higher than the other.
Cyclophoria, where the one eye tends to rotate round an antero-posterior axis.

Symptoms.—Eyes which have heterophoria are never in quite a restful condition when awake, and it is only by an effort that they are kept parallel; the result is that these patients often complain of a tired, strained feeling in the eye, which is not altogether remedied by the correcting of any refractive error which may exist. This is called muscular asthenopia. It frequently happens, however, that a patient is unaware of the heterophoria and it produces no symptoms. Hyperphoria is the most likely condition to produce asthenopia. Esophoria and exophoria, although sometimes troublesome, frequently give rise to no symptoms.

Tests for Heterophoria.—The desire for binocular vision is so great that under ordinary circumstances fusion is possible, but if by artificial means the image of a certain object is so distorted or altered when seen with one eye that it bears no resemblance to its true appearance as seen with the other, then the desire for fusion no longer exists and the eyes assume their position of rest, and the dissimilar images are seen more or less separated from each other. According to the position of the images so we ascertain which muscles are affected.

Maddox Rod consists of four or five pieces of glass rod placed close together and parallel, and mounted in a metal disc, made to fit the trial frame. These form a series of very strong cylindrical lenses. If now a candle flame is looked at through such a battery of rods at a distance of about twenty feet, instead of having its ordinary appearance it converts it into a long streak of light which has no resemblance to the candle flame as seen with the other eye, and consequently

there is no tendency for the eye to make any effort to fuse them. The contrast is made still more striking if a red glass be placed in front of the other eye, when the candle flame will appear coloured and of its ordinary shape, while the line will be white. Should the condition of *orthophoria* be present the white line will run through the red candle flame (see Fig. 84).

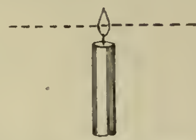
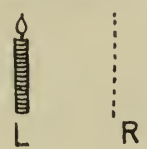


Fig. 84.—Orthophoria.

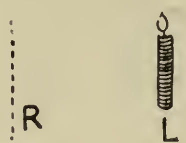
The line will run vertical or horizontal according to the horizontal or vertical position of the rods in the trial frame.

Should we place the rod in the right side of the trial frame and the red glass in the left we should get the following—

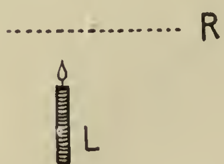
In *esophoria*—
Fig. 84*a*.



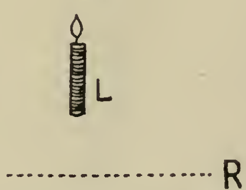
In *exophoria*—
Fig. 84*b*.



In *left hyperphoria*—
Fig. 84*c*.



In *right hyperphoria*—
Fig. 84*d*.



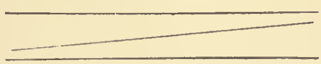
For near vision the Maddox double prism is most useful. This consists of two prisms placed base to base in an ordinary trial lens mounting. This is placed in the trial frame with

the line between the two prisms running horizontally across the centre of the pupil. If now a patient looks through this at a horizontal line drawn on a piece of white paper or cardboard, he sees one image of the line displaced upwards and another downwards, and the true image as seen with the other eye is exactly midway between the other two. If the prisms were placed before the right eye three lines would be seen, thus—

Should there be any hyperphoria the centre line will be nearer the upper or the lower line; and if esophoria or exophoria were present the centre line will be displaced to one side or the other, thus—

Esophoria with hyperphoria.

Should cyclophoria be present the lines will not be parallel, and the lines will appear thus—



Insufficiency of Convergence.—This is not quite the same as exophoria. A patient may have no exophoria when looking at a distance, but may be much troubled with insufficient power of convergence when looking at near objects. If he has no more exophoria or no less esophoria for near things than for distant objects, there is no insufficiency of convergence. If, however, he has more exophoria for near than for distant things (or, what amounts to the same thing, less esophoria under these conditions), then he has insufficient convergence.

Symptoms.—These are pain, tiredness and discomfort of the eyes after reading and doing near work; the pain is usually most marked about the brows, and there is a tendency to hold things a long way off.

Treatment.—Exercises will usually strengthen the weak muscles and the patient should be instructed to practise his convergence. A good way is to make him look at a pencil held up at arm's-length, then gradually to bring it slowly in until it is so near that only with the greatest effort of convergence can the object be seen as one, and if it is brought any nearer it becomes double. When still seen as a single object it should be looked at for several seconds, and then gradually it is drawn away from the eye and the convergence is relaxed. If the patient will do this simple exercise for two or three minutes two or three times a day, the weakened internal recti will soon become stronger and the symptoms will disappear.

The same thing can be accomplished by making the patient read a book and gradually approach it as near as possible to the eye until the printing can only just be seen, then moving it away again. Assistance may be given to the internal recti by prescribing prisms bases inwards combined with reading glasses should these be required. It must be remembered that this error is somewhat frequently present in presbyopes, and when it is, care should be taken that the glasses ordered be rather weaker than would otherwise be necessary, so that the patient may be able to read with the book further away than is usually desirable. If such people be given a full correction it makes them most uncomfortable.

Concomitant Squint.—This is the ordinary squint seen in persons whose eyes are obviously not parallel to each other, and differs in this way from the latent squint, or heterophoria, which has previously been described, and which gives rise to no deformity. Although vertical squints are sometimes seen, yet they are rare; those which are usually met with are due to a horizontal displacement of one or other eye, they are either convergent or divergent; and they are not due to paralysis. The paralytic cases form a group by themselves, and are discussed under their own proper heading. In concomitant strabismus it makes

no difference which way the eyes are moved, the squint is there all the time, and is thus very different from the paralytic cases, in which the eyes squint more and more as the patient endeavours to look in the direction of the affected muscle.

A patient suffering from concomitant squint is able only to fix with one eye at a time, for obviously it would not be possible for him to direct the two eyes on the same distant object, for if he could he would have no squint. In the majority of cases one eye is defective, and the patient habitually uses the better eye to the exclusion of the other. If, however, the fixing eye be covered, then he will use the deviating one, and behind the object which is shading the better eye it will now be observed that this is squinting as much as the other did before. This is called secondary deviation. The two eyes maintain the same angle of squint under all conditions.

Convergent Concomitant Strabismus.—This is by far the commonest variety of squint, and usually first makes its appearance in children when they become old enough to take an interest in things, and use their eyes for looking at toys, pictures, etc. At first a child is indifferent as to which eye he fixes with if both are of about equal visual acuity; but before very long he gets into the habit of always fixing with one eye and always squinting with the other. Should there be a difference in the sight of the two eyes he quickly decides which is the better, and habitually uses it.

Etiology.—The vast majority of children who develop convergent strabismus are hypermetropic; sometimes both eyes have an equal error, but at other times one is more out of focus than the other, and when this is the case they usually fix with the eye which has the lesser defect. Convergence and accommodation are so closely associated that if a child has to accommodate to a considerable extent in order to overcome his hypermetropia, he will also converge more than is necessary. When this happens the two

eyes are not directed on to the object which is being looked at, and consequently diplopia is produced, but at this early age binocular vision has not been fully established, and it does not take long for the child to mentally suppress the image he sees with the squinting eye, and he then disregards it, so that the eye never has any practice, and consequently the seeing power undergoes no development. Unless this abnormality be checked before he arrives at the age of six or eight years the eye becomes permanently amblyopic, and it is impossible in the majority of cases to get the sight up to normal standard after this time. It is, therefore, of the greatest consequence to see that the eye is not neglected in the early days of the squint. Should binocular vision be really established it can never be lost so long as the patient has two seeing eyes, and the desire for it is sufficiently great to prevent the development of a squint. There is a popular belief that a child squints because he imitated some one else who did so, or because a lock of hair hung down on his forehead which he looked at constantly. It is often ascribed to measles, whooping-cough or such-like ailments, but it is probable that these things have little if anything to do with it. Children squint because they see better with one eye in focus than with both eyes out of focus, and so the unused eye does not develop its function, and although it never becomes absolutely blind, yet so far as direct vision is concerned it is almost useless. Such people are thus deprived not only of binocular vision, but they are functionally one-eyed people, except for the fact that the amblyopic eye increases the size of the field of vision, and it saves a patient having a totally blind side.

The longer a squint remains, in other words, the longer a child is allowed to use one eye and exclude the other, the greater is the chance of it becoming amblyopic, so that as soon as ever a tendency to squint is noticed it is the duty of the surgeon to find out what defect of sight is responsible for it. The cause is present in the eye or some

part of the visual apparatus, while no child is ever too young to commence treatment. Some of the worst cases of amblyopia are seen in children who have squinted since infancy, and who are supposed to be too young to wear glasses, so that the short but precious time has been allowed to pass during which it would have been possible to have prevented the development not only of the squint but also of the amblyopia. Among the poorer classes parents frequently act on the principle of waiting to see whether the child will grow out of the squint; they always however, grow into it, and usually lose to a large extent the sight of one eye during the process. It should be remembered that the squint itself is by far the least important feature of the case. An eye can always be put straight by operation, but when once the patient has passed the age of six or seven years but little if any improvement in the sight of the amblyopic eye can be obtained.

Although most people with convergent squint are hypermetropes, yet this cannot be the only cause, for the vast majority of children are hypermetropic and yet do not squint, while a squint of this kind may occur in a person who is emmetropic or even myopic. It is also a fact that a squint has little if any relation to the amount of hypermetropia present. Some high hypermetropes never squint at all, and one is often surprised at the very small refractive error which is present in some squinting eyes.

Although no one can doubt the great influence which errors of refraction have in bringing about squint, there are certainly other factors, and one is the failure of development of the fusion faculty. Another is a failure in the development of equal vision in the two eyes, due either to unequal refraction, whereby the vision of one eye is greatly superior to that of the other, or to the presence of a corneal nebula which may produce such a blurred image that the desire for fusion, which has scarcely yet been developed, is altogether suppressed, and the child is content to use the better eye only. If binocular vision had been fully

established this mental suppression of the image seen with one eye would not have been possible.

We sometimes find a squint present in a patient who has two equally good eyes, and such a person may be quite indifferent as to which eye he fixes with, but he cannot of course direct the two eyes together on to one object. In these cases the fusion faculty is wanting. Although in the great majority of cases an error of refraction, or something interfering with the vision of one eye, is responsible for the squint, and in most of them the vision of the two eyes is unequal, yet some are no doubt due to a failure in development of some part of the visual centres in the brain. It is also possible that the fusion faculty which is in a rudimentary state of development may be prejudicially affected by any serious disease. In spite of this the surgeon should always assume that the cause of the squint is some defect of sight, and the sooner this is recognized, and if possible treated, the better it will be for the patient.

It will be gathered from what has been said that those patients with concomitant squint without binocular vision are not troubled with diplopia. The vast majority of squints of this kind are developed in childhood, and the greater number first appear at about the third year. Sometimes it may be present almost from birth, and at other times a child may be as old as six or seven before it is noticed, but this is exceptional.

Treatment.—But few convergent squints would require treatment by operation if the surgeon only saw them early enough. The first thing to find out is the cause of the squint. It is always safe to assume, in the absence of other evidence to the contrary, that there is a refractive error, usually hypermetropia or hypermetropic astigmatism. If the child is old enough to know his letters he may be placed before the test types and his vision with each eye be recorded. If he is not old enough to give reliable answers it makes no difference.

Atropine is ordered either in the form of ointment or

drops of 1 % to be used to both eyes three times daily for two or three days, after which the pupils should be dilated and the ciliary muscle relaxed. The fundus is examined and the refraction determined by retinoscopy. Should the child be old enough the vision should again be taken and recorded, but if not the correction found by retinoscopy (making due allowance for the atropine) should be ordered (see Chapter II). It is far better practice to order the glasses found to be necessary (making due allowance for the atropine) than to allow a child's statement as to what he can or cannot see to influence the surgeon in writing his prescription. A careful retinoscopy done under atropine is far more likely to be correct than a statement made by a child who has never really developed his seeing powers to any high degree.

Fig. 85.—Harman's method of fitting spectacles on a young child.

When it comes to correcting a refractive error *no child is ever too young to wear spectacles*. Worth was one of the first to insist on this principle. It is no more difficult to get an infant of a few weeks old to wear glasses than it is to get him to wear ordinary garments. Suitable frames must be provided, and Worth recommends steel frames with large round glasses and very short sides which reach only just to the baby's ears. These have a hole at the end of them through which a piece of tape may be attached. This tape passes round the back of the child's head and is made fast to the other arm of the spectacle. Harman has also suggested an ingenious device (see Fig. 85). A piece of tape is passed through the loops at the end of the spectacle sides and is tied on the top of the head after having been placed beneath the occiput. Thus the tape and spectacles mutually keep each other in place.

Should the surgeon see the child within a few weeks or

even months of the first appearance of the squint, in the majority of cases the eyes will become straight. In the early stages the mere use of atropine, which paralyses the accommodation, will cause the squint to disappear. Such cases are particularly hopeful, for the glasses will also prevent the excessive use of the accommodation, and the fusion faculty will soon develop and will prevent all further tendency to excessive convergence. If the squint be of longer standing but little difference will be noticed after atropine has been used, for by this time the convergence has become established and the child still prefers to use his better eye. Even with the glasses the same thing occurs, and no immediate benefit is noticed. In all these cases the glasses must be worn continually and never be removed until bed-time. Other means must now be taken to ensure the use of the squinting eye. One of the simplest methods is to hamper the sight of the better eye, such as by keeping it under atropine. If this be done the child will probably see near things better with the squinting eye, which has its accommodation unimpaired than he does with the better eye without its accommodation. Should this not be sufficient the better eye may be closed with a pad and bandage for several hours a day, or even for several weeks on end; but the child must be carefully watched, otherwise he is sure to shift the pad sufficiently to enable him to see with the eye which is supposed to be closed. Another way is to have a black disc made to fit over the spectacle glass of the better eye. This method of exclusion of one eye must be carried out with care, and not be allowed to go on indefinitely, for if it is, the eye which was amblyopic may become the fixing and seeing one; and the original fixing eye may become the amblyopic one. The only result of the treatment will have been to transfer the squint from one eye to the other. All these cases must be kept under the constant supervision of the surgeon. It was at one time a common practice to endeavour to keep the accommodation of both eyes quiet by the use of atropine until the child was con-

sidered old enough to wear glasses. This unfortunately produced the most hopeless cases of amblyopia, for if the squinting eye was not doing its work under normal conditions how much less likely was it to do it when hampered with a mydriatic. Atropine should never be used for the squinting eye except for the few days which are necessary previous to working out the refraction.

In order still further to assist the defective eye the stereo-

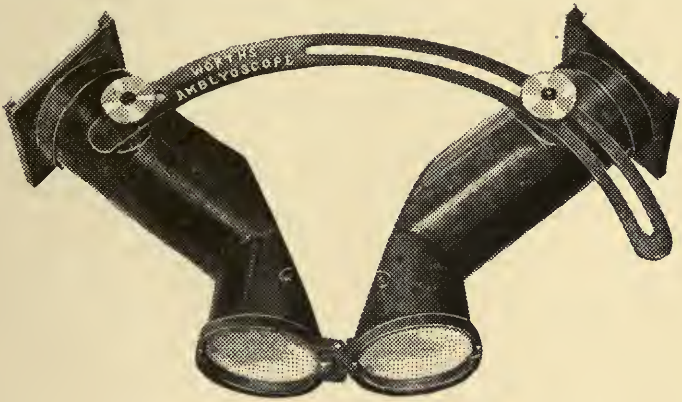


Fig. 86.

scope is often called into requisition. The ordinary stereoscope is not of very much use, for the child looks through it and sees the picture with the good eye only, and no real binocular vision is developed.

If exercises of this sort are contemplated, by far the best form of stereoscope is one suggested by Worth and called the amblyoscope (Fig. 86). It consists of two tubes which can be adjusted to the requirements of the case. Part of a picture, such as a bird, is placed in one tube, and the other part, say the cage, is placed in the other tube. The two halves may be unequally illuminated, so that the image seen with the defective eye may be made much brighter than that seen with the fixing eye. The child now has to look into the two tubes until he can see the bird in the cage. As

the sight gets stronger so the extra light can be diminished, until at last both parts of the picture are seen equally well. In some such ways as these the amblyopia may be much reduced or cured, and at the same time the squint be lost.

A cheaper form of stereoscope and pictures has been suggested by Dr. Cunningham of Belfast.

It sometimes happens that a squint may become cured spontaneously, but the sight is by no means necessarily improved. Unless a person has developed the functional activity of an eye by the time he is six or seven years of age he seldom has anything but very defective sight in the squinting eye. If an adult in this condition be unfortunate enough to lose his fixing eye and has only the amblyopic eye to depend upon, although it may improve a little, say from $\frac{6}{60}$ to $\frac{6}{36}$, or even to $\frac{6}{24}$, it seldom does more than this, proving beyond doubt that the visual faculties must be developed in very early life, and no amount of practice will subsequently be able to make up for the lost time.

Concomitant Divergent Squint appears in two forms: one is the result of myopia and the other is neuropathic in origin. The divergence which occurs as the result of myopia is usually seen in moderately high degrees of short-sightedness. It generally develops during school life, and is brought about in the following manner. When a myope attempts to do near work without glasses he has to hold the object so close to the eyes that excessive convergence is required if both eyes are to be directed on to it. This causes symptoms of fatigue, until some day the patient finds he is able to get on perfectly well if he covers one eye. He soon learns to see with one eye only while both are open. Under these conditions convergence is not required, and from disuse the internal recti are quickly overcome by the external, and very soon an actual divergence takes place when near things are examined. After a time the squint becomes more marked and is present even when distant objects are looked at. It nearly always happens that eyes diverge to a considerable extent and low degrees of

divergence are less common. Nearly all people with occasional divergent squint have binocular vision when the eyes are straight and the fusion faculty is developed, but they seldom complain of diplopia. In cases where the vision is very defective a faint image seen in the periphery of the diverging eye is soon disregarded, and the higher the degree of divergence the less distinct will be the second image, and there will be no complaint of diplopia.

Although myopia is by far the most common cause of a divergent squint, yet anything may produce it which makes it unnecessary for the patient to exercise convergence. If one eye becomes blind or its vision so impaired that it is useless for binocular vision, divergence is very likely to occur. It is often seen in cases of monocular cataract, and in those in which there is a serious fundus lesion. If the patient be hypermetropic convergence may develop instead of divergence.

Neuropathic Divergent Squint is usually present from infancy, and is due to faulty power of convergence, the refraction may be normal. The fusion sense is nearly always absent. Usually these patients are of the neurotic type, with bad family history as regards nerve diseases.

Secondary Divergence.—This is far less frequently seen than it used to be. In former days all people who were treated for convergent squint had one or both internal recti divided, and in order to produce the necessary effect in cases of high degrees the lateral expansions of the tendon were divided upwards and downwards. This was a most dangerous proceeding, for although the eye immediately became straight and pleased both the patient and the surgeon, yet the internal recti became re-attached to the globe so far back, or failed to re-attach themselves at all, that very soon the external recti, acting unopposed, caused divergence, and the power of convergence became lost. At the same time the caruncle became sunken and the eyes proptosed. These cases presented a very typical and by no means a sightly appearance.

Measurement of the Angle of a Squint.—The peri-

meter may be made use of for this observation. Suppose the patient has a convergent squint of the left eye. The chin is placed in the rest and the patient is told to look over the top of the instrument to an object twenty feet or so away in the direct line of sight. This he will do with his right eye. The arc of the perimeter is placed horizontally on the patient's right side. Consequently the convergent eye will be directed across this arc. In order to find out exactly the direction of the optical axis of the squinting eye a lighted candle is moved along the arc until the surgeon (whose eye is directly behind the candle) sees the reflection of the flame in the centre of the cornea. The arc being marked in degrees the position which the candle occupies can be at once read.

Should the left eye be divergent the arc would be swung round through 180° until it was on the patient's left-hand side. The arc has always to be placed on the side corresponding to the direction of the optical axis of the squinting eye.

This method cannot be used in children, and is not so good as the deviometer described by Worth, the Maddox tangent scale, or the Priestley Smith's tape method, but it is not possible or necessary to describe these instruments here.

Treatment.—In the early stages of divergence due to myopia the accurate correction of the patient's refraction will very often prevent its development. With glasses it is not necessary for a patient to hold a book so near his eyes as without them, so that this relieves the excessive effort or the internal recti, and only a normal amount of convergence is required. Inasmuch as divergence is caused by a weakness of the internal recti, and not by over-action of the external, advancement of the internal rectus in one or both eyes is by far the best treatment. Should this not be sufficient a tenotomy of the external may be done, but the greatest care must be taken not to cut more than the tendon, and to leave intact its lateral expansions into the capsule

of Tenon. The less, however, that is done to the external recti in the way of tenotomy the better. For details of the operation see Chapter XVII. The refraction should of course be corrected.

The neuropathic cases should be treated by the operation of advancement; tenotomy should not be done if it can possibly be avoided.

The secondary divergent cases must all be treated by advancement of the internal rectus; tenotomy of the external rectus is worse than useless. Owing to the matting of the parts together as the result of the previous operation, considerable difficulty may be experienced in finding the much-atrophied internal rectus. It will often be discovered tucked away behind the caruncle and close to the inner wall of the orbit.

CHAPTER XVII

OPERATIONS ON THE EXTRAOCULAR MUSCLES

When a squint exists it is because one muscle overpowers the other which opposes it. It is obvious that they may be made equal either by strengthening the weaker muscle or by weakening the stronger. The former is accomplished by attaching the tendon of the weaker muscle nearer to the cornea, and the latter by dividing the tendon of the stronger.

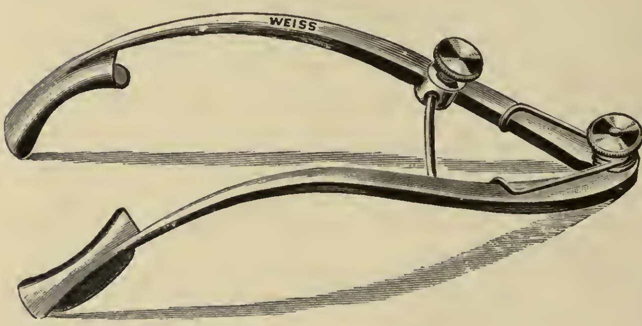


Fig. 87.—Eye speculum.

Tenotomy.—If we have a convergent squint we can put the eye straight by dividing the internal rectus which is drawing it in. In order to do this drops of 2% cocaine and adrenalin should be applied to the eye for ten or fifteen minutes. With the patient lying on his back, and the surgeon standing below and on the right hand, he inserts a speculum. The patient is then told to relax the muscle as much as possible by looking as far outwards as he can with the eye on which the operation is being performed;

in other words, to contract his external rectus and slack away his internal. The conjunctiva over the surface of the

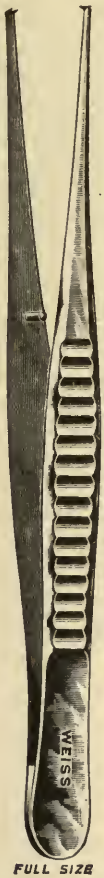


Fig. 88.—Fixation forceps.

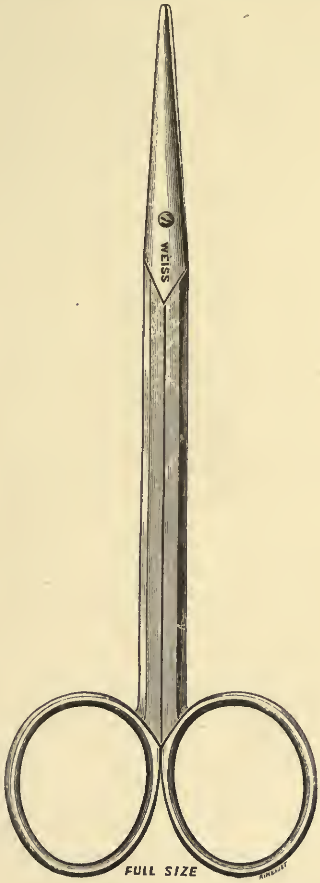


Fig. 89.—Squint scissors.

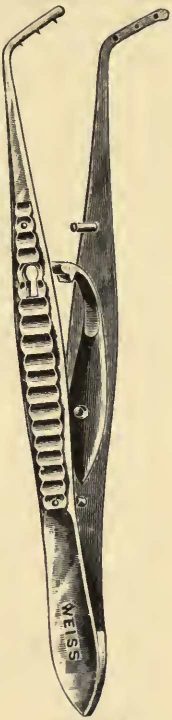
Fig. 90.—Squint hook.

tendon is picked up with the forceps (Fig. 88), and an incision about one third of an inch long at right angles to the tendon is made with a pair of straight scissors (Fig. 89). The capsule of Tenon is divided in exactly the same way, and then the

tendon of the muscle is seen. This may be divided in two ways. The simplest is to expose the tendon completely and pick it up with forceps and divide it with scissors. The other method is to pass a squint-hook (Fig. 90) beneath it and divide the muscle between the hook and the eyeball. In doing this the greatest care must be taken to avoid wounding the sclera. Fortunately it very seldom happens, but when cutting with scissors on an eyeball with a muscle stretched tightly across the hook this accident may happen. It is impossible for this to occur if the tendon be fully exposed and picked up with forceps before it is divided. There is very little pain produced unless the muscle is dragged forwards and stretched; therefore, whether a hook be used or not, the muscle should be treated most gently. After the tendon is divided a suture or two may be placed in the conjunctiva. It is impossible to cure a convergent squint of more than about 10°, or, at the most, 15°, by a single tenotomy, *i.e.* if the tendon only is divided; but if its prolongations into the capsule of Tenon above and below are cut, far more effect can be produced. This, however, should on no account be done, it is altogether unjustifiable, for although a high degree of squint may by this means be cured immediately, the eye is certain to diverge afterwards, and will produce an external squint worse than the convergent one for which the operation was undertaken. If more than about 15° is required the external rectus should be advanced. It is not very satisfactory to try and cure a divergent squint by a simple tenotomy. Division of the external rectus does not produce much more than half the effect that tenotomy of the internal rectus gives. The eye should be kept closed, with a pad and bandage, for two or three days after the operation.

Advancement of One of the Recti Muscles.—Most surgeons have their own particular modifications of performing this operation. One of the best is that which was introduced by Claud Worth, and with his kind permission it is given here in his own words. The particular operation described is that for advancing the internal rectus.

"The instruments required are speculum (Fig. 87), straight blunt-pointed scissors (Fig. 89), fixation forceps (Fig. 88), advancement forceps (Fig. 91), needle-holder, needles and thread. The thread should not be thick. It is preferable to prepare the thread by boiling it in wax. The needles are medium-sized curved needles with large eyes. The eye is anæsthetized with cocaine or holocaine. Adrenalin is instilled before and from time to time during the operation. The patient lies on a table with his feet towards a window. His lids are held open by the speculum. The surgeon, standing behind the patient's head, grasps the conjunctiva with the toothed forceps, while with the scissors he makes a straight vertical incision through it about half-an-inch long. The middle of the incision is close to the corneal margin. A similar incision is made through the capsule of Tenon. The conjunctiva and capsule then retract, or, if necessary, they are pushed back so as to expose the insertion of the tendon. If the angle of the squint is of high degree, the vertical incision through the membranes is made curved instead of straight, the convexity of the curve being towards the cornea. This is to allow the membranes to retract more freely. One blade of the advancement forceps is now passed under the tendon after the manner of a tenotomy hook, the other blade being superficial to the conjunctiva. The forceps is now closed, so that tendon, capsule of Tenon, and conjunctiva are all firmly clamped together, with their relations undisturbed except for the retraction of the membranes. The tendon and a few little fibrous bands beneath the tendon are now divided with scissors at their insertion into the sclerotic.



FULL SIZE

FIG. 91.—Advancement forceps.

The advancement forceps, holding the tendon, capsule and conjunctiva, can now easily be lifted up, so as to get a good view of the under-side of the muscle.

"One of the needles is then passed inwards at A, through conjunctiva, capsule and muscle, and brought out at the under-side of the muscle. It is again passed through the

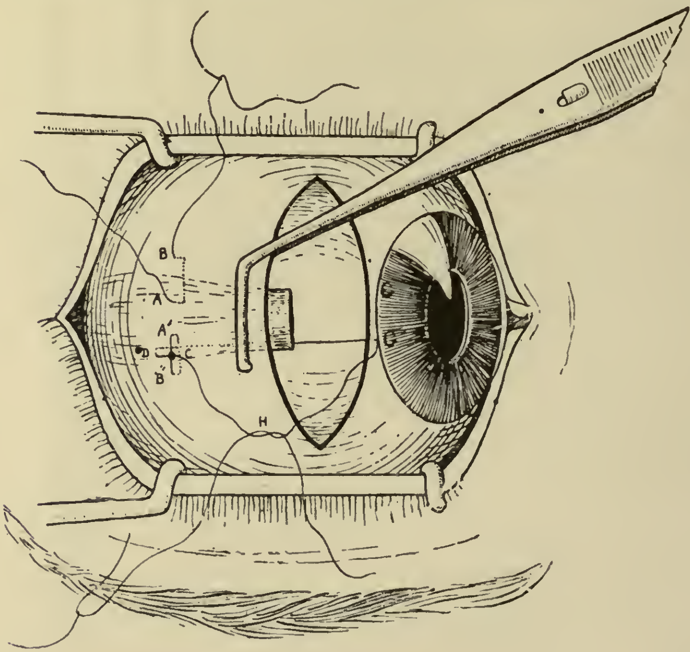


Fig. 92.

muscle, capsule and conjunctiva, and brought out at B. The bight of the thread thus encloses about the lower fourth of the width of the muscle, together with its tendinous expansion and capsule and conjunctiva. The other needle is similarly entered at A′, passed through conjunctiva, capsule and muscle, and brought out at the under-side of the muscle. It is then entered again at the under-side of the muscle, and brought out through the conjunctiva at

B′, the bight of this suture thus enclosing the upper fourth of the width of the muscle, etc. The object of inserting both sutures before proceeding further with either is that they may be symmetrically placed. The ends of the thread from A′ to B′ are then crossed over at C. The end bearing the needle is then entered at D, and passed through conjunctiva, capsule and muscle, and carried beneath the lower blade of the advancement forceps nearly to the corneal margin. The needle is here passed through the tough circumcorneal fibrous tissue, and brought out at G′. The tied ends of the thread are then temporarily tied loosely, with a single hitch, at H. The first suture is then similarly completed. The anterior part of the muscle and capsule and conjunctiva are then removed by cutting them through with scissors, behind which they are grasped by the advancement forceps. The gap is then closed by tightening and securely tying each suture at HH, so that the eyeball is rotated in its correct position, and the anterior end of the muscle is brought nearly up to the corneal margin at GG′.

"In operating under cocaine, before the knots are tied at HH, an assistant holds the globe in the primary position with forceps, while the patient is told to try and look away from the operated muscle. This relaxes the muscle while it is being drawn forwards by the suture. The sutures are then temporarily secured at HH by the first hitch of the 'surgeon's knot.' The assistant then relaxes the globe. The fine adjustment is done by tightening or loosening the hitches at HH, the result being checked by the mirror test or by the reflection of a candle-flame on the cornea. The 'surgeon's knots' at HH are then completed."

Subconjunctival Reefing and Advancement (Bishop Harman's Operation).—"In this operation the tendon is not cut. The upper and lower edges of the tendon to be shortened are exposed by two button-holes through conjunctiva and capsule, then with special forceps the tendon is folded or reefed very much in the fashion that the laundress treats linen frills in goffering. The

reef is then sewn up. The operation is variable with the degree of squint: (*a*) For squint up to 15° to 18° reefing only is done, the reef is graded by the set of the blades of the reefing forceps; in adults each millimetre of shortening will secure 2·5° rectification, in children 2°; (*b*) in high degrees of squint a 10 mm. reef is made, secured by sutures and drawn towards the cornea by fixing the sutures into the sclero-corneal margin before tying them.

"*Instruments.*—Reefing forceps, tendon rasp, scissors, forceps, needle-holder, three No. 4 curved needles threaded with doubled No. 1 silk, 6″ long, speculum, three pieces of strapping 1½ by ½″ long.

"*Stages of the Operation* (say on the external rectus for convergent squint)—

"1. Secure the eye by inserting one of the three sutures into the sclera close to the limbus; this stitch serves as fixation forceps during the operation, and as an anchor to fix the eye in abduction at the end of the operation. Give the suture to the assistant to hold the eye in full adduction ready for the next step.

"2. Locate the tendon. When the eye is adducted and the lids parted the site of the tendon is seen as a horizontal bluish band, whilst the conjunctiva above and below has a creamy tint. These colour differences are well seen in children.

"3. Cut two button-holes through conjunctiva and capsule right down to the sclera, above and below and parallel to the edges of the tendon, and midway between insertion and canthus, *i. e.* about 8 mm. from the canthus.

'4. Pass the tendon rasp beneath the tendon to feel it, then scrape the upper and lower surfaces of the tendon with the rasp.

"5. Apply the reefing forceps. Hold the handle over the external canthus, pass the lower hook beneath the tendon, then lift the conjunctiva over the upper hook. Lock the blades. Then slowly turn the forceps from the outer canthus across the eye until the handle comes to rest on the nose. The tendon is reefed.

"6. Sew up the base of the reef. Lift the forceps, pass the needle into the opening of the conjunctiva, dip it below the hooks of the forceps, and bring it out through the tendon and conjunctiva towards the outer canthus; pass the suture once again in exactly the same fashion, draw the silk tight and the reef is gripped at one edge in the bight of the suture. Secure the other edge similarly. Loosen the clamps of the forceps and remove. If reefing only is to be done for a low degree of squint thread a small glass bead on each suture

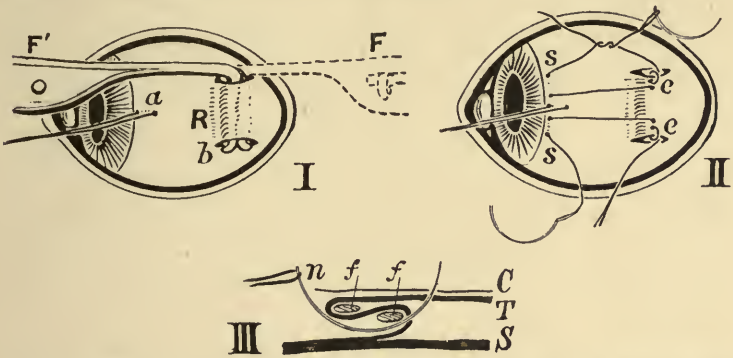


FIG. 93.—Subconjunctival reefing and advancement, *a*, anchor stitch; *b*, the button-holes through conjunctiva and capsule parallel to the edges of the tendon; *F*, position of reefing forceps on insertion; F′, position of forceps after turning on to nose to make reef *R*; reef under conjunctiva.

e marks base of reef secured in bight of suture (when reefing only is desired the sutures are tied at this stage); *s*, sutures fixed in the sclera ready for tying to advance the reef.

Section to show: *R*, reef held by *f*, *f*, blades of reefing forceps; *n*, needle passing through base of reef; *C*, conjunctiva; *T*, tendon; *S*, sclera.

and tie in a surgeon's knot. If more than 18° is required insert each suture into the sclera close to the cornea so as to advance the reef. Thus: take hold of the anchor stitch, hold it parallel to the vertical meridian, then pass the needle of each of the reef sutures from the anchor stitch through the conjunctiva and into the sclera parallel to the limbus, one above the anchor and one below. Tie each suture in the first turn of a surgeon's knot, draw as tight as desired, then complete the knot.

"The sutures lie outside the conjunctiva except where they dip down to grip the sclera and to secure the reef.

"7. Finally abduct the eye by means of the anchor stitch. Tie this on to a piece of strapping placed at right angles to the canthus, then secure the ends with another piece of strapping set T-fashion over all. The anchor stitch relaxes the antagonist of the operated muscle and protects the reef from too early strain.

"Bandage the eye. If spectacles are worn fix with strapping a piece of card over the outer half of the lens of the open eye and along the bow; this blinker compels the patient to look towards the operated muscle and relieves the strain on the anchor stitch.

"The patient may be allowed out of doors at once. Wash and dress the operated eye daily, remove the anchor stitch on the third day, and the reefing sutures on the tenth day. The rucking of the conjunctiva smooths out in about six weeks, and the scar regresses rapidly."

CHAPTER XVIII

COLOUR-BLINDNESS

There is no subject in ophthalmic science which has been so much discussed and argued over as Colour-Vision and its defects. This has been chiefly due to efforts made to make facts fit theories which never were capable of explaining them. These theories have been held to with marvellous persistence, probably because of the distinguished scientists with whom they are associated. The chief of these theories are the Young-Helmholtz and the Hering.

The Young-Helmholtz theory supposes three sets of colour-perceiving elements in the retina—red, green and violet—and by their combination all other colours are produced.

Hering supposes the existences of three different visual substances in the retina, which when being disintegrated produce the sensations of white, red and yellow, but when being regenerated they produce the sensations of black, green and blue. Probably no one holds the Hering theory now, but some still struggle to uphold the theory of Young and Helmholtz. One simple observation is sufficient to disprove both, and it is this. No one has ever found the retina of a colour-blind person to differ in the slightest degree anatomically or physiologically (with the one exception of colour-vision) from any other healthy retina, while scarcely a known fact of colour-blindness can be explained by either. Again, if yellow is a combination of red and green, if we exhaust the eye for green, yellow ought to disappear and become red. It does nothing of the kind, but the yellow is as visible as ever it was, and this proves it could not be a compound sensation. No more than this need be said.

Edridge-Green was the first to really throw light upon the subject, and his theory, which has this advantage, that there is not one single fact relating to colour-vision which cannot be explained by it, is as follows :—

The rods of the retina secrete and hold the visual purple and distribute it as required; the cones are the sensory nerve endings which are stimulated when the visual purple is liberated. These being the terminal ends of the optic nerve cells and fibres, cause impulses to travel to the brain and light is perceived. The impulses differ in degree, and are passed on to a colour-perceiving centre in the brain, where they are analysed and sorted. Now if this centre is fully developed all the colours of the spectrum are perceived, if ill-developed some only are recognized, and if the centre barely exists total colour-blindness is the result.

In order to understand this it must be remembered that light consists of impulses of various wave-lengths. The largest ones give the sensation of red at one end of the spectrum, and the smallest give the sensation of violet at the other end. In order to be perceived at all the impulses must be composed of certain definite wave-lengths, the smallest being of about 760·4 millionths of a millimetre, and the largest about 396·8 millionths of a millimetre. It must likewise be realized that there is no such thing as colour apart from light, and that an object is red or green, for instance, because it absorbs all coloured rays from the light except the red or green which it reflects and so to us appears to be one or other colour.

We well know that besides these visible rays there are millions of others which are invisible to our retina. If too large they are the ultra-red or heat rays, and if too small they are the ultra-violet or chemical rays.

A normal-sighted individual is capable of seeing six colours in the spectrum—red, orange, yellow, green, blue and violet; while the colour sense is so highly developed in some people that they are able to see a seventh colour situated between the blue and violet, and this is termed

indigo. Only about one person in several thousand is capable of seeing indigo in the spectrum as a distinct colour.

The colour-vision became developed as follows—

In the primitive state the whole spectrum was visible as a grey band, and one part differed from another only in luminosity. This condition we may call monochromatic vision. As the centre became larger the rays of least refrangibility gradually became perceptible as differing from those of greatest refrangibility, and one end of the spectrum became tinged with red, the other end with violet, and the intermediate part was still grey; but as development went on the red and violet ends expanded and occupied more and more of the neutral grey band until they actually met, and there we have the dichromic cases with or without a neutral band separating the two colours.

Now as the centre still further developed it became capable of distinguishing between rays which differed less in refrangibility or wave-lengths than do the red or violet, and the greatest difference of course occurred at the centre, and between the two colours red and violet. When this took place the central rays were seen as green, and thus we got the trichromics, who see red, green and violet in the spectrum.

The next colour to be perceived will occur as before, where the greatest difference in wave-lengths is present, and this will be between the red and green, and so we get yellow, separating these two colours. We thus have the tetrachromic or four-unit people, who perceive red, yellow, green and violet. The next point of greatest difference will be between the green and violet, and here we get blue appearing, and so we get the pentachromic or five-unit people, who perceive red, yellow, green, blue and violet. The next point of greatest difference will be between the red and yellow, and here we get orange interposing itself, and so we get the hexachromic or six-unit people, who perceive in the spectrum red, orange, yellow, green, blue and violet. This is the state of colour-vision in the majority of mankind at the present time. The next point of greatest difference will

be between the blue and violet, and indigo will be perceived, and this gives us the heptachromic people, who see seven colours in the spectrum: viz. red, orange, yellow, green, blue, indigo and violet. No one has ever yet been known who could see eight colours in the spectrum, and very few can see seven, but when an eighth colour is perceived it will be where the next greatest difference is seen, and that will be between the red and orange. We can thus theoretically split up the spectrum into any number of colours, but at present the human eye is incapable of appreciating more than six or at the most seven. We can theoretically lengthen the spectrum indefinitely, but likewise no eye has yet ever been capable of seeing the waves of higher and lower intensity than are included between the wave-lengths, 760·4 millionths of a millimetre and 396·8 millionths of a millimetre.

Now it is a fact that among the human race every one of the seven stages described above is met with, from the monochromic to the heptachromic; and we also have large groups of people whose spectrum is shortened at the red or violet end, so that these are those who fail to see rays of light which are visible to the normal-sighted, and there are those whose visual range does not extend as far as 760·4 millionths of a millimetre at the red end, nor to 396·8 millionths of a millimetre at the violet end.

This somewhat lengthy though perfectly simple explanation is absolutely necessary for the student to master if he is to classify and detect cases of defective colour-vision with which he will come in contact.

For practical purposes the surgeon has to separate the cases into those who are so defective in colour-sense that they are a danger when they have to read coloured signals, such as railway men and seamen, and those who are normal-sighted, and who will never make a mistake.

If their defect be so slight that their only difficulty consists of an inability to tell orange from yellow, or blue from green or violet, *i. e.* the pentachromic or tetrachromic groups, they will be safe enough, because no signal lights

would ever be shown which would make these lights of the slightest value. The best of us would often make mistakes between a blue and a violet light, or an orange and a yellow light, seen at a distance or in fog. It, therefore, amounts to this, that we must be able to separate the mono-, di- and tri- chromics from the rest. The first group are all dangerous, and the second group are all safe, except, perhaps, some of the tetrachromics who are bordering on the trichromics.

There is, however, one other set of people who, though they may belong to the safe group, according to the colour classification, yet are a source of great danger, and these are they who have shortening of the red end of the spectrum. It is well known that the rays which will penetrate a fog further than any other, are the red, and the further they are removed from the orange the more they will penetrate, and they will be the very last rays to be lost if the fog becomes so thick that they are unable to get through it. (It is a familiar sight to see the sun on a foggy day look a dark-red colour; this is because the fog has already cut off all but the red rays, and these are still capable of penetrating the mist.) If now a person has half the red end of the spectrum invisible, a red light which may be plainly seen by a normal-sighted person will be invisible to him, and so he may with the greatest confidence run his train past a red light and never know it is there.

If violet lights were used for signals a person with a shortened violet end of his spectrum would be also equally dangerous, but unless these lights are used shortening of this end is of no practical importance.

Any test which is to be of service must be capable of detecting the dangerous from the non-dangerous people, and these are the one, the two, the three and the worst of the four-unit people from the best of the four, the five, the six and the seven-unit people, and also those with a shortened red end of the spectrum. This is the entire problem which the surgeon has to solve.

Colours must be named.—Any test which excludes the

naming of colours is practically useless. It may also be stated that colour-ignorance apart from colour-blindness, does not exist, that is to say, that a person of average intelligence who will call a yellow light green or red, is a person who does not see the difference between these colours. No one of course wants a signal-man to be able to name such colours as puce, magenta, electric blue, etc., and all the fine distinctions which are made by drapers and such-like, but it is absolutely necessary that a man should not be allowed to interpret coloured signals who will under any possible conditions not know the colours which he must recognize and name (at least mentally) which are shown to him in his daily or nightly occupation.

Some of the finest matchers of colours are found among the dangerously colour-blind, and many a man will never match a green with any other colour, say in sorting wools, who does not see the colour green at all; but by its luminosity he is capable of putting all the green wools together, and yet if suddenly confronted by a light of unknown colour will probably call a green light either yellow or red. If these facts are once grasped the testing of the colour-blind, which to some surgeons is still such a difficult problem, will become perfectly clear. Some colour-blind people are so sharp in distinguishing by shade and luminosity that they will appear to have no defect at all, and will be passed as normal by many of the tests in common use.

The persons to be excluded from railway and marine look-out work are: (1) those who see less than four colours in the spectrum; (2) those who, while they may have four or more colours in the spectrum, have the red end so shortened that they are unable to see a dim red light at a distance which is bright enough to be seen by a person with normal sight; and (3) those who, while they may have normal colour-vision for near things, are unable to distinguish between red, green and white lights at a distance, though such lights are still visible to them but are more or less of one colour.

Tests for Colour-Blindness.—No test which depends

upon matching coloured fabrics or coloured lights is reliable. A reliable test can only exist when it depends upon a person naming the colours seen.

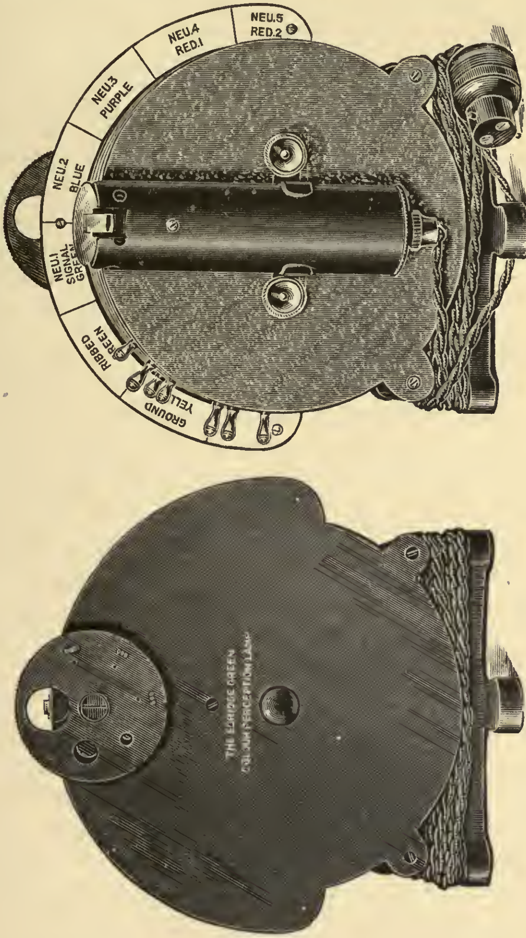


Fig. 94.—Edridge-Green's colour perception lamp.

The best test by far is a lantern, and of the many lanterns made, the Edridge-Green variety is better than any other.[1]

[1] Made by Reiner & Keeler, 9 Vere Street, W.; and E. B. Meyrowitz, 1A Old Broad Street, W.

It consists of an electric or oil lamp before which four discs each carrying seven pieces of glass are rotated. Three of the discs contain coloured glass, and one of them seven modifying glasses—which are ground glass, ribbed glass and five thicknesses of neutral glass. It has a diaphragm which is graduated so as to represent a signal bull's-eye at 600, 800 and 1000 yards' distance.

Each of the colours in the three colour discs are precisely the same, and they are (1) red, (2) red (of a different density), (3) yellow, (4) green, (5) signal green, (6) blue, (7) purple.

The candidate should be placed in a dimly lighted room and at a distance of about twenty feet from the lantern. He should be asked to name the colours of the lights produced either by single coloured glass or by combinations. He should then have the lights modified by the modifying glasses to see if he is still able to name them properly. The candidate should be rejected (1) if he calls the red, green, or green, red; (2) if he calls a white light red or green, or a red or green, white; (3) if he fails to see a red, green or white light which is sufficiently intense to be visible to a normal-sighted person. All kinds of combinations of colours should be shown with and without modifying glasses.

The Bead Test.—This is a very useful and very simple test which Edridge-Green has introduced. It consists of a small tray containing a large number of various coloured glass beads of different sizes, which are all exposed to view. One part of the tray is divided into four compartments with a small cover to each, and in the middle of each cover is a hole. The first compartment is labelled red, the second yellow, the third green and the fourth blue. The candidate is given a pair of forceps and told to pick out beads and drop them into the hole according to their colour. This is the easiest thing possible for a person to do with normal colour-vision, but extremely difficult for a colour-blind person. It has this great advantage, that the candidate is unable to see any bead which he has once dropped into the hole, neither can he take it out again. In this way no comparison

is possible. When he has finished the examiner removes the covers and sees what has been done.

The classification test consists of four test skeins of wool and 180 confusion colours; 150 of them are coloured skeins of wool, 10 of silk, 10 small squares of coloured cardboard and 10 of coloured glass. The test skeins are (1) orange, (2) violet, (3) red and (4) blue-green. The candidate should be asked to name the colours, or if necessary to match

FIG. 95.—Edridge-Green's bead test for colour-blindness.

them. This somewhat resembles at first sight the Holmgren test, which consists of coloured wools which the candidate is asked to match, but it really differs in nearly every respect from it, because the colours are to be named, as well as matched, while the Holmgren test excludes all colour names, matching only being allowed. The wools are of very different colour from those of Holmgren, and the test contains substances other than wools. The bright surface of silk is very confusing to the colour-blind when compared with the dull surface of wools. This is a useful secondary test, but nothing like so reliable as the lantern, which possesses many advantages.

The *Colour Perception Spectrometer* is a magnificent instrument, but it is far too costly and troublesome to use in routine examination, but it may be used as a final appeal, and will absolutely determine the exact state of colour-vision in an individual, no matter in what stage of development his colour-sense may be.[1]

These tests are sufficient for the examination of every possible case of normal and modified colour-vision in existence. There are dozens of other tests which cannot be entered into here. The subject is too extensive to go into in more detail, but if the surgeon will master the theory and the practice as here set out, he will have no difficulty in carrying out his examinations in a satisfactory manner.

Defective tests and wrong theories are entirely responsible for the state of uncertainty and chaos with which the whole subject has been shrouded for years. It must be insisted on that this detection of colour-defects is a highly technical branch of ophthalmic science, and none but those acquainted with the physiology of vision should ever be entrusted with the examination of candidates.

Because these facts are not recognized, we get the truly marvellous returns which certain public bodies publish as the result of the examination carried out by lay examiners with defective tests.

[1] This instrument is made by Hilger & Co., 75A Camden Road, N.W.

CHAPTER XIX

VISUAL REQUIREMENTS FOR VARIOUS PUBLIC SERVICES

Royal Navy.—Candidates for naval cadetships must possess full normal vision as determined by Snellen's tests, each eye being separately examined (*i. e.* $\frac{6}{6}$ and Sn. 0·6 or J 1).

Candidates for other branches of the Royal Navy—full normal vision is not required, but any defect of vision must be due to errors of refraction which can be corrected to normal by glasses, and vision without glasses must in any case be not less than $\frac{6}{60}$ with each eye, and he must also be able to read Sn. 0·6.

Imperfect colour-vision will disqualify a candidate, so also will any chronic disease of eyes or eyelids, lacrimal apparatus, squint or any defect of the ocular muscles.

The following ratings are required to have full normal acuteness of vision without glasses. The seamen class, marines (except bandsmen), armourers, engine-room artificers, electricians and boy artificers.

For candidates for other artisan ratings and for stokers, the vision must be at least $\frac{6}{8}$. For all other ratings, including writers, ship-stewards' assistants, ship's cooks, sick-berth staff, officers' stewards and cooks, the vision must not be less than $\frac{6}{12}$. Ship's cooks' ratings and officers' servants are not disqualified by colour-blindness; all the others are.

Defects of vision must be due to errors of refraction only, and must be capable of correction to $\frac{6}{6}$ by means of glasses, the candidate must be able to read Sn. 0·6 without glasses. Marine bandsmen, sick-berth staff, writers, ship's stewards' ratings, ship's cooks' ratings and officers' servants, are allowed to wear glasses.

The British Army.—Snellen's types are used, and for distant vision the candidate will be placed at a distance of twenty feet or six metres. Each eye will be examined separately and the lids must be kept wide open during the test. The tests must be read without hesitation and in ordinary daylight. Any defect of vision allowed in the following standards must be due to an error of refraction only, and such error must not exceed the limits mentioned: (*a*) in the case of myopia 2·5D; (*b*) any correction for astigmatism must not exceed 2·5D, and in myopic astigmatism the total error of refraction must not exceed 2·5D.

Subject to these conditions the standards of the minimum acuteness of vision with which the candidate will be accepted are as follows:—

Standard I

Right Eye.	*Left Eye.*
Distant Vision $\frac{6}{6}$.	Distant Vision $\frac{6}{6}$.
Near Vision Sn. 0·6.	Near Vision Sn. 0·6

Standard II

Better Eye.	*Worse Eye.*
Distant Vision $\frac{6}{6}$.	Vision without glasses not below $\frac{6}{60}$, and after correction with glasses not below $\frac{6}{24}$.
Near Vision Sn. 0·6.	Near Vision Sn. 1.

Standard III

Better Eye.	*Worse Eye.*
Distant Vision without glasses not below $\frac{6}{24}$, and after correction with glasses $\frac{6}{6}$.	Vision without glasses not below $\frac{6}{24}$, and after correction with glasses not below $\frac{6}{12}$.
Near Vision Sn. 0·8.	Near Vision Sn. 1.

For officers in the Special Reserve, if Standard III is used a candidate will not be disqualified if his distant vision without glasses is not below $\frac{6}{36}$.

Inability to distinguish the principal colours will not be regarded as a cause for rejection, but the fact will be recorded and the candidate will be informed.

No relaxation of the standard of vision will ever be allowed.

Recruits for all Arms of the Military Service.—All recruits will be examined by Snellen's types, and the following regulations will be observed.

Each eye will be tested separately.

(*a*) If a recruit can read $\frac{6}{24}$ with each eye without glasses he will be considered fit.

(*b*) If he can read not less than $\frac{6}{36}$ with one eye without glasses and $\frac{6}{6}$ with the other without glasses he will be considered fit.

Army Schoolmasters.—Candidates will be accepted if the examining medical officer is satisfied that his vision with or without glasses is good.

Home Civil Service.—No definite rules are laid down, but any serious defect of vision disqualifies.

Indian Civil Service, *i. e.* Ecclesiastical, Education, Geological, Survey, Agricultural, Indian Finance, Customs, Civil Veterinary and other Departments not specially provided for.

(1) The candidate will be admitted if ametropic in one or both eyes, provided that with glasses he sees not less than $\frac{6}{9}$ with one eye and $\frac{6}{6}$ with the other, there being no morbid change in the fundus of either.

(2) If myopic the ametropia in either eye is not to exceed 2·5D with no active morbid changes in choroid or retina, though he may have a posterior staphyloma.

(3) If the defect of vision is due to a corneal nebula he will be disqualified if his vision is less than $\frac{6}{12}$ in either eye, and in such case the acuteness of vision in the better eye must equal $\frac{6}{6}$ with or without glasses.

(4) Squint or any morbid condition subject to risk of

aggravation or recurrence in either eye may cause the rejection of a candidate. The existence of imperfection of colour-sense will be noted.

The Departments of Forest, Survey, Telegraph, Factories and for Various Artificers[1] in the Indian Civil Service.

(1) If myopia in one or both eyes exists the candidate may be passed if it does not exceed 2·5D, and if with correcting glasses not exceeding 2·5D he sees $\frac{6}{9}$ with one eye and $\frac{6}{6}$ with the other, there being normal range of accommodation with the glasses.
(2) If myopic astigmatism exists the combined spherical and cylindrical glass must not exceed −2·5, and with that one eye must see not less than $\frac{6}{9}$ and the other $\frac{6}{6}$.
(3) A candidate having total hypermetropia not exceeding 4D is not disqualified provided the sight in one eye (when under atropine) equals $\frac{6}{9}$ and the other $\frac{6}{6}$, with +4D or any lower glass.
(4) Hypermetropic astigmatism will be allowed if the combined lenses required to correct the error do not exceed 4D, and that with or without the glasses the sight is equal to $\frac{6}{9}$ in one eye and $\frac{6}{6}$ in the other.
(5) If the defect is due to a corneal nebula the sight of one eye must not be less than $\frac{6}{12}$. In such a case the better eye must be emmetropic. Defects of vision from pathological or other changes in the deeper structures of either eye which are not referred to in the above rules may exclude a candidate.
(6) Squint or any morbid condition, subject to risk of aggravation or recurrence in either eye, may cause the rejection of a candidate. The existence of imperfection of colour-sense will be noted.

[1] Artificers engaged in map and plan drawing may be considered separately, and this standard relaxed if it appears to be desirable.

Public Works Department and Superior Establishments, Railway Department of India.

(1) If myopia exists it must not exceed 3·5D, but if with a 3·5D glass the candidate sees $\frac{6}{6}$ with one eye and not less than $\frac{6}{9}$ with the other he will be passed. Range of accommodation must be normal.

(2) If myopic astigmatism exists the combined spherical and cylindrical glass must not exceed 3·5D, and with this the vision must be equal to at least $\frac{6}{9}$ in one eye and $\frac{6}{6}$ in the other. Range of accommodation must be normal.

(3) Hypermetropia must not exceed 4D, and the sight of one eye (when under atropine) must equal $\frac{6}{9}$ and the other $\frac{6}{6}$ with a $+4$ glass or one of any less power.

(4) Hypermetropic astigmatism is allowed if the combined correcting glass does not exceed 4D, and that the sight with or without lens equals $\frac{6}{9}$ in one eye and $\frac{6}{6}$ in the other.

(5) If a corneal nebula exists the vision must not be less than $\frac{6}{12}$ in that eye, but the other eye must be emmetropic. Defects of vision arising from pathological or other changes in the deeper structures of the eye which are not referred to in these rules may exclude a candidate.

(6) Squint or any morbid condition subject to risk of aggravation or recurrence, in either eye may cause the rejection of a candidate. Any imperfection of the colour-sense is a disqualification for appointment to the Engineering Branch of the Railway Department, or as Assistant Superintendent in the Traffic Department. In all other cases a note as to any imperfection of the colour-sense will be made.

The Indian Medical Service and the Police Department.—The standard required for these services is precisely

the same as required for commissions in the Regular Army (not including the exceptions allowed for the Special Reserve). In all other respects candidates for these two branches of the Indian Service must come up to the standard laid down for candidates for commissions in the Army.

Indian Pilot Service, and Candidates for Appointments as Guards, Engine-drivers, Signalmen and Pointsmen on Railways.

(1) A candidate is disqualified unless both eyes are emmetropic, his acuteness of vision and range of accommodation being perfect.
(2) A candidate is disqualified by any imperfection of his colour-sense.
(3) Strabismus or any defective action of the exterior muscles of the eyeball disqualifies a candidate.

Indian Marine Service, including Engineers and Firemen.

(1) A candidate is disqualified if he have an error of refraction in one or both eyes which is not neutralized by a concave or convex 1D lens or some lower power.
(2) He is disqualified by any imperfection of his colour-sense.
(3) He is disqualified by strabismus or any defective action of the exterior muscles of the eyeball.

Special Duty in India.—Candidates for special duty under the Indian Government must possess such an amount of acuteness of vision as will, without hindrance, enable them to perform the work of their office for the period their appointment may last. In all cases of imperfection of colour-sense a note will be made on the candidate's papers.

Royal Irish Constabulary.—A candidate for cadetship in the Royal Irish Constabulary must be able to read with each eye separately, and without glasses, Snellen's

Metrical Test Types (edition 1898). Number D = 10 at twenty English feet, and those numbered D = 0·8 at any distance selected by the candidate. Squint, inability to distinguish the principal colours or any morbid condition liable to aggravation or recurrence in either eye will involve rejection of the candidate.

Board of Trade Tests for the British Mercantile Marine.—The published regulations for the lay examiners which the Board of Trade employ for testing of eyesight is written in language which is not technical, and is consequently difficult to understand. As far as can be understood the intention is as follows :—

Candidates will be tested with each eye separately and no glasses are allowed.

"If he can read correctly nine out of the twelve letters in the sixth line ($\frac{5}{6\cdot 7}$) from the top, and eight of the fifteen letters in the seventh line ($\frac{5}{5}$) with one eye, and the whole of the eight letters in the fifth line ($\frac{5}{10}$) with the other eye, he may be considered to have passed the test. If he cannot do so his case should be submitted to the Principal Examiner of Master and Mates."

"Every candidate who fails to pass the form test is to be examined with the pellet test as follows :—

"The pellets should be placed on a white plate, and the first test pellet (which is of the same colour as the first wool-test skein) should then be placed at a little distance from the box on a white plate. The candidate should be required to pick out and lay by the side of the test pellet all pellets of the same colour. The same should be done with the other test pellets, and the examination should proceed in the same way as the wool test."

Colour-Vision Test.—The colour-vision of candidates is to be tested by means of Holmgren's wools. Five test skeins are now used : (1) light green, (2) pink, (3) red, (4) purple, (5) yellow.

"(7) During the colour-vision test the examiner should avoid naming the colours of any of the wools, and should explain to the candidate that he does not require them to be named to him."

Colour-Ignorance Test.—"(1) The object of this test is simply to ascertain whether the candidate knows the names of the three colours, red, green and white, and the test is to be confined to naming these colours."

"(2) One or two of the purest red and green skeins should be selected from the set of wools, and the candidate should be required to name their colours. He should also be required to name the colour of any white object, such as a piece of white paper."

INDEX

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